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ABSTRACT

Designed for grades four through six, this guide contains 21 interdisciplinary lessons on energy which were developed to assist Arkansas teachers in incorporating energy education into existing curricula. Program objectives are listed under four broad categories: (1) energy sources, alternatives, and conversion; (2) energy uses; (3) conservation; and (4) limits and impacts. Each lesson follows a uniform format which includes category of objectives, title, related subject areas, energy types, grade level, time, materials, learning objectives, task analysis (prerequisite knowledge and skills), and procedure (preparation, steps in lesson, evaluation and follow-up activities). A section on teacher background information and student worksheets follow each lesson. A glossary, list of selected references, and program evaluation forms are provided. (DC)

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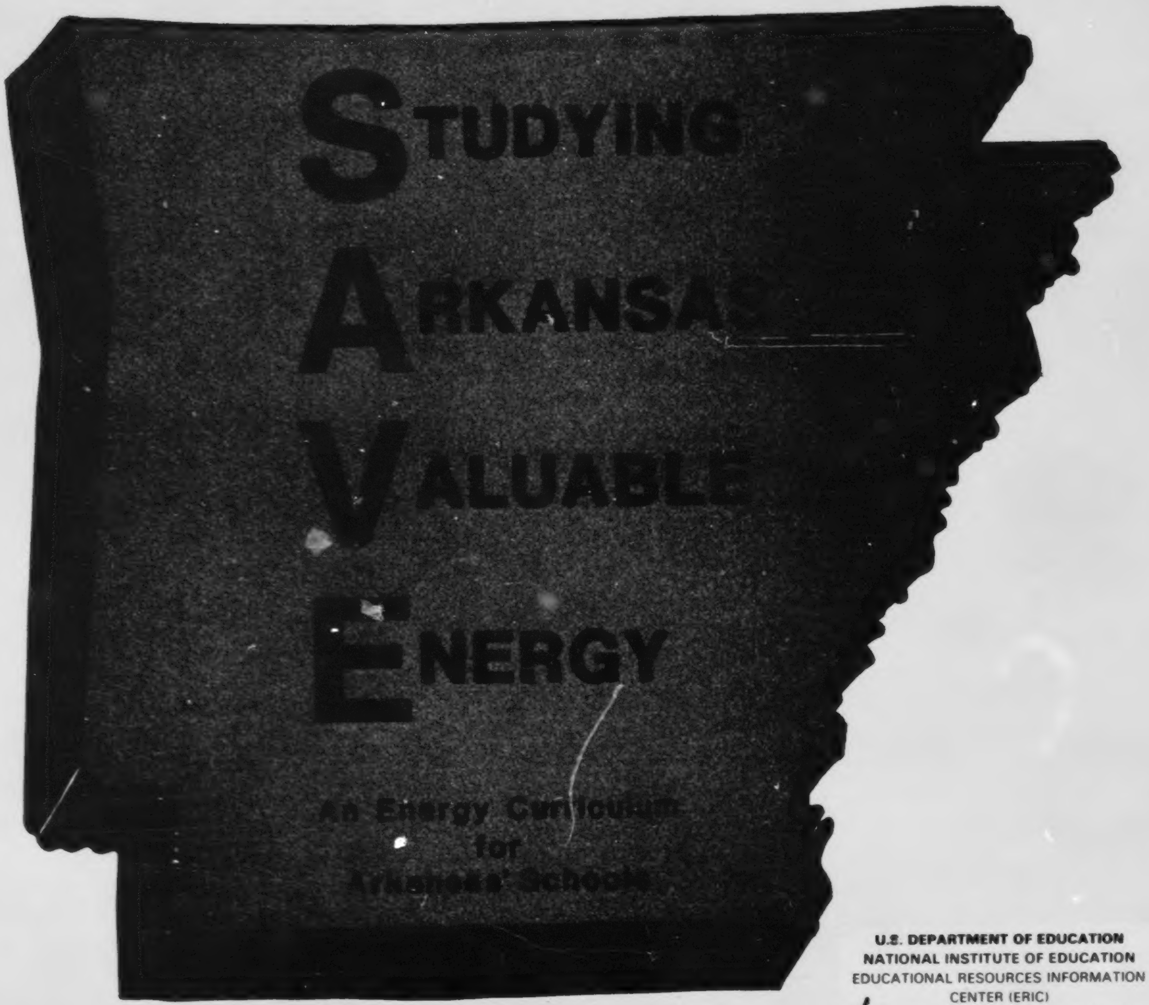

STUDYING ARKANSAS VALUABLE ENERGY

An Energy Curriculum
for
Arkansas' Schools

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SE 036 242

Arkansas Department of Education

S.A.V.E.

STUDYING ARKANSAS' VALUABLE ENERGY

An Energy Curriculum For Arkansas' Schools

GRADES 4-6

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1981

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Subject areas: Consumer Education, Economics, Social Studies, Language Arts

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PREFACE

In recent years Arkansans and Americans have become increasingly concerned about the energy dilemma and its important role in their lives. New research and technology can alleviate part of the problem but an immediate source of relief can be the reduction of energy use. Effective energy conservation can result in substantial savings in energy consumption and extend the longevity of present energy supplies.

The energy situation provides almost endless possibilities for students to learn about the world, their nation, their state, and themselves. The comprehensive and complex nature of the energy situation provides an excellent base for the study of the interactions and relationships among resources, environment, economics, society, politics and behavior.

Energy brings challenge and opportunity to education. The challenge is basic: preparation for survival. The opportunity is to learn from real world problems and to demonstrate how education can contribute to solutions.

The younger generation is the key to the solutions of our energy problem. They also stand to enjoy or suffer the consequences of the problem. The subject of energy, containing some of the most crucial issues of our time, deserves a place in the school curriculum at all levels in all subjects. Energy is an essential element of everything we do.

Studying Arkansas' Valuable Energy represents an effort by the Arkansas Department of Education to assist the schools of Arkansas in planning and carrying out effective energy education programs. It is hoped Studying Arkansas' Valuable Energy will increase awareness and understanding of the energy situation and will encourage each student to become an energy conservationist.

Studying Arkansas' Valuable Energy is premised on the following:

SOURCES, ALTERNATIVES, CONVERSIONS

Individuals should understand that:

- there are many sources of energy.
- presently fossil fuels provide most of our energy sources but alternative sources including direct solar, hydro, wind, nuclear fission, biomass, geothermal, and nuclear fusion must be considered and/or developed.
- energy/matter is a fixed commodity being neither created nor destroyed but converted from one form to another; individuals should understand the means of conversion and the by-products of conversions.

USES

Individuals should understand that:

- energy is so basic that nothing moves or is accomplished without it.
- people are dependent upon energy.

- in the United States 75 per cent of our energy is derived from oil and natural gas; in Arkansas we have almost 90 per cent dependence on oil and natural gas.

CONSERVATION

Individuals should understand that:

- the supply of energy sources is finite; the need for conserving energy supplies is real and urgent.
- efficient use of energy resources is one of our best ways of maintaining our current life style.
- half the energy being used in the United States (and in Arkansas) is wasted.

LIMITS AND IMPACTS

Individuals should understand that:

- the earth's resources are limited.
- man's use of energy creates an impact on the environmental and economic systems.

Studying Arkansas' Valuable Energy is intended to aid Arkansas teachers in integrating energy education into existing curriculum. The lessons are designed to be used by classroom teachers in grade levels K - 12. Most of the lessons require the students to be actively involved, both with other students and in actual use of materials.

The lessons have been designed with an interdisciplinary approach, and an attempt has been made to provide a flexible "package" which may be adopted or adapted to fit particular classroom needs. The instructor is free to modify lessons (or activities within lessons), and to use as many or as few lessons and activities as desired or needed.

Each lesson is uniformally organized as follows:

Category (Sources, Alternatives, Conversions; Uses; Conservation; Limits and Impacts)

Title

Related subject areas

Energy type(s)

Grade level

Time needed to complete lesson (in class periods)

Materials needed

Learning objective(s)

Task analysis (knowledge and skills required of students before undertaking a lesson)

Procedure

Preparation

Steps in lesson

Evaluation

Follow-up activities

These lessons are continually undergoing field testing and revisions to obtain the best possible materials to present to students. In the event that you, as a classroom teacher, wish to contribute more to the program of energy education, the Arkansas Department of Education will be happy to hear from you. Your comments and suggestions concerning subject matter, organization, materials, and activities will be welcomed.

There are evaluation forms included at the back of the unit. We request that each teacher who uses lessons complete and return an evaluation form to the address given.

The Arkansas Department of Education wishes to thank the Arkansas Energy Office and in particular, Ms. Carol Gaddy, for reviewing and critiquing the many lessons of Studying Arkansas' Valuable Energy.

Curricular materials used in assembling Studying Arkansas' Valuable Energy include the following:

Energy and Man's Environment. Energy and Conservation Education: Activites for the Classroom Grades 1-12. Energy and Man's Environment: Portland, Oregon. 1978.

Indiana Department of Public Instruction. An Energy Curriculum for the Elementary Grades. Indiana Department of Public Instruction: Indianapolis. 1979.

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Nebraska Energy Office. Energy Conservation Activity Packet. Nebraska Energy Office: Lincoln. 1977.

North Carolina Department of Public Instruction. Energy Activities—Making the Most of What We Have. North Carolina Department of Public Instruction. Raleigh. 1979.

Oklahoma State Department of Education. Energy Awareness Education. Oklahoma State Department of Education: Oklahoma City. 1977.

Pennsylvania Department of Education. Pennsylvania Energy Curriculum for the Middle Grades. Pennsylvania Department of Education: Harrisburg. 1977.

Superintendent of Public Instruction. Energy Trade Offs in the Marketplace. Superintendent of Public Instruction: Olympia, Washington. 1980.

Tenneco Incorporated. Schoolhouse Energy Efficiency Demonstration (SEED). Tenneco Incorporated: Houston. 1980.

United States Department of Energy. Various materials. Technical Information Center: Oakridge, TN.

LESSON #1

CATEGORY: Sources

ENERGY TYPE: Electricity

TITLE: Making Electricity

GRADE LEVEL: 4

INFUSE WITH SUBJECT AREA:

TIME NEEDED: One period

Science
Math

MATERIALS:

Bicycle
Small DC motor
Flashlight
Bulb
Copper wire for connectors
Masking tape
4 or 5 buckets of water
Metal coffee can lid
Awl
Hammer
Tin snips
Wooden dowel or straightened coat hanger

OBJECTIVES:

1. The students will observe how a turbine wheel turns.
2. The students will label a diagram showing the necessary steps in converting a natural source of energy to electrical energy.
3. The students will list several sources of electrical energy.
4. The students will identify electrical energy as secondary energy.

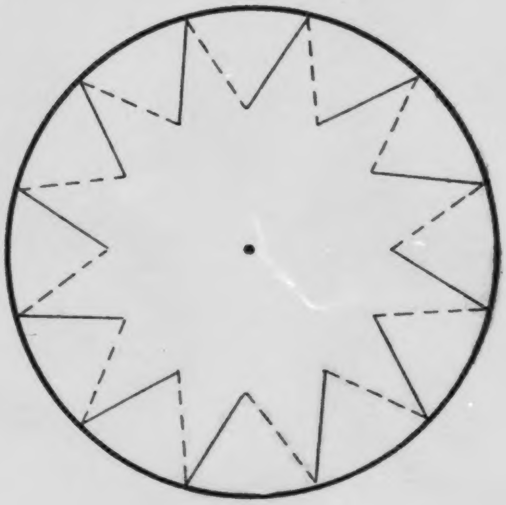
TASK ANALYSIS:

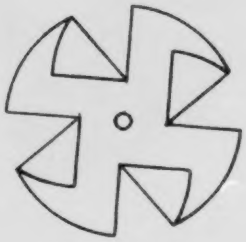
The students should be able to take oral directions and work in small groups.

PROCEDURE:

1. Preparation

   Collect the materials listed above.
   Construct a model turbine wheel:
   - Take a metal coffee can lid
   - Punch a hole in the center of the lid
   - Cut the lid with tin snips on the solid lines as illustrated
   - Fold on the dotted lines as illustrated
   - Use a wooden dowel as an axle through the hole





- Place 4 or 5 buckets of water outside the classroom
- Have a student turn a bicycle upside down in the classroom
- Duplicate Student Worksheet 1.6 (Conversion Review Sheet)

2. Steps in Lesson

Objective #1: The students will observe how a turbine wheel turns.

a. Explain and discuss with the students the fact that electrical energy is converted from other energy sources.

b. Take the class outside and let them participate in the water/turbine demonstration. Have students pour water over the wheel and ask:
   - Does the wheel turn faster if the water is poured faster?
   - Does the wheel turn faster if there is more water poured?
   - What happens when there is only a trickle of water poured?

c. Return to the classroom and ask the students if they would like to make electricity.
   - Take the DC motor and wrap the shaft with the masking tape. Continue wrapping until the shaft is about 1/2 cm in diameter.
   - Tape one copper connecting wire to the end of the light bulb. Tape another copper connecting wire around the metal part of the bulb.
   - Go to the upside down bicycle.
   - Have one student turn the bicycle pedals with one hand with the other hand hold the motor shaft so it just touches the spinning tire.
   - Increase the speed of the wheel and notice what happens. Explain to the students that they have just made electricity through mechanical motion. The movement of the bike wheel turns the generator which produces electricity.

Objective #2: The students will label a diagram showing the necessary steps in converting a natural source of energy to electrical energy.

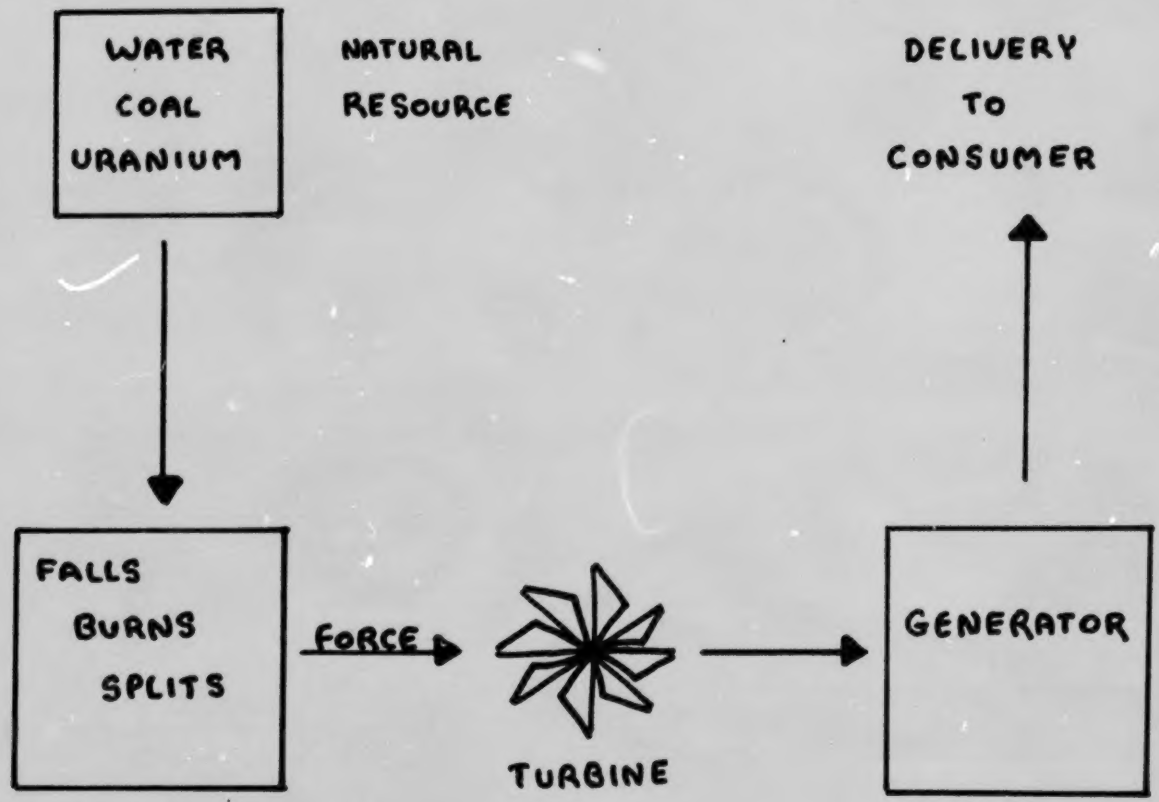
Objective #3: The students will list several sources of electrical energy.

Objective #4: The students will identify electrical energy as secondary energy.

a. Ask the students to remember the experiment of pouring water over the wheel and the experiment of spinning the bicycle wheel and relate both to the generation of electricity we use.

b. Have the students compare the similarities in the process of generating electricity even though the source differs.
   - Share the diagram below.
   - Discuss with the students the fact that electrical energy is converted from a primary source such as water, uranium, coal, oil, or natural gas.

c. Discuss why electrical energy is called secondary energy.



3. **Evaluation**

Distribute Student Worksheet 1.6 (Conversion Review Sheet) and have the students complete. Let the students compare answers and review the generation of electricity with them.

4. **Follow-Up Activities**

Have the students write a paragraph explaining how we get electricity from falling water (trapped water is released and flows through turbines which activates generators that make electricity) or one of the fossil fuels (burned in a furnace to heat boilers that produce steam which turns a wheel called a turbine, which drives a generator that produces electricity).

TEACHER BACKGROUND INFORMATION

It was about one hundred years ago that a coal-fired steam engine was joined to a generator and the first central-power-generating station turned on the lights of New York City (1882). Today, electricity is no longer a rarity; in fact, it is an important part of our way of life.

The generation of electricity begins with the conversion of a natural energy source such as water, coal, oil, natural gas, or uranium. These natural sources are extracted from the earth as concentrated stored energy and are relatively easy to convert to electricity. Electricity is, therefore, considered a secondary source of energy.

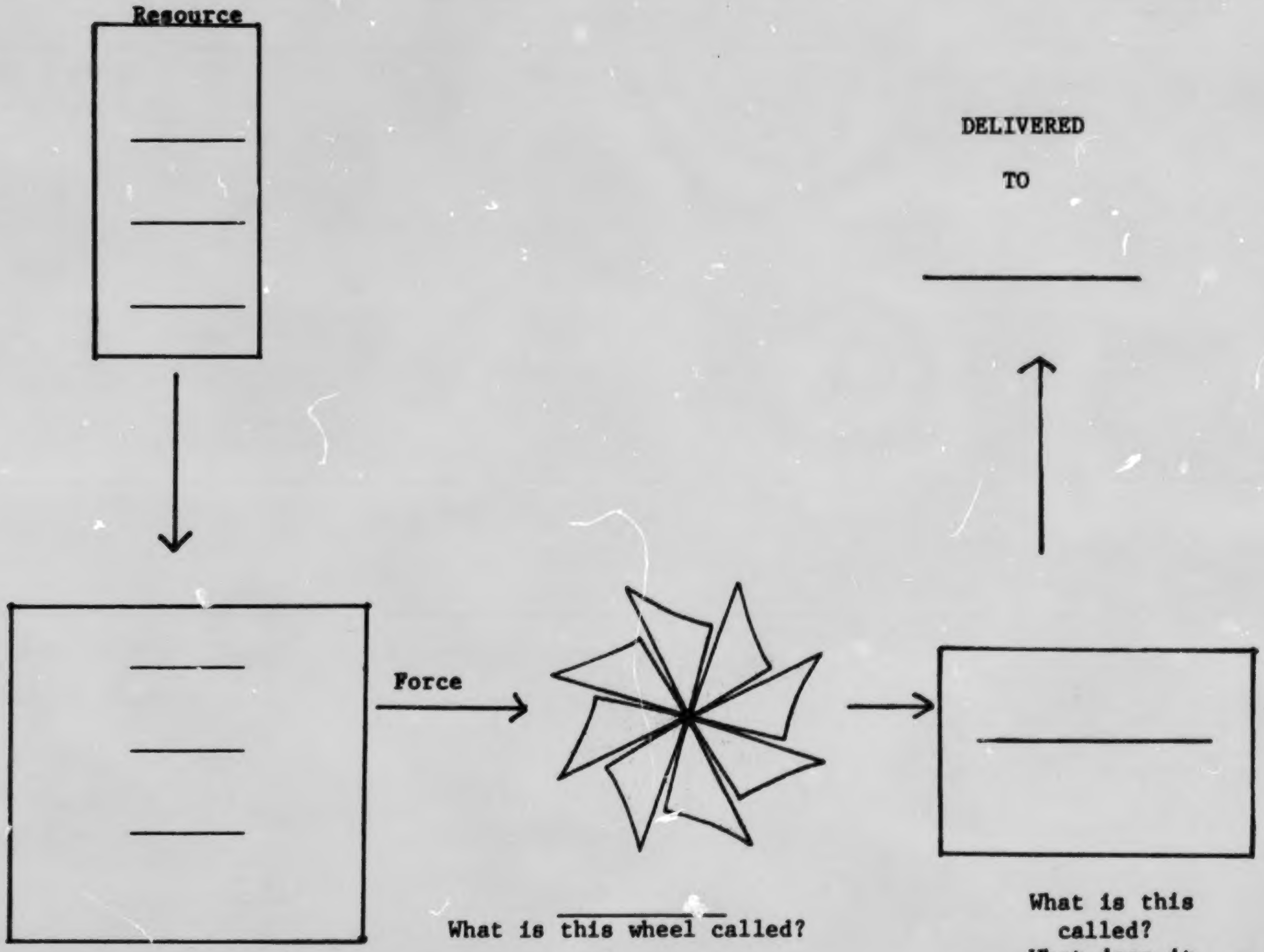
In generating electricity the source may vary but the steps are basically the same. Electricity is the energy that is derived from electrons that are in motion. For example when converting coal to electricity the coal is heated in a furnace which causes water to boil. The steam that is produced is then allowed to escape which creates enough force to turn the turbines. The wheel and axle that is called a turbine turns rapidly and causes the moving part of a generator to produce electricity. It is at this point that this usable electricity is transmitted by wire to transformers and substations and eventually to consumers.

Conversion Review Sheet

Directions: Fill in the blanks and answer the questions.

1.6

Student Worksheet



Resource

Name Three Sources

____

____

____

What Happens To The Source?

____

____

____

Force

What is this wheel called? ________

____

What is this called?
What does it do.________

____

DELIVERED TO

____

Source: United States Department of Energy

LESSON #2

CATEGORY: Sources

ENERGY TYPE: Primary Energy Sources

TITLE: Arkansas' Primary Energy Sources

GRADE LEVEL: 4-6

INFUSE WITH SUBJECT AREA:

TIME NEEDED: One period

Science
Social Studies
Math

MATERIALS:

None

OBJECTIVE:

The students will be able to interpret diagrams of Arkansas sources of energy.

TASK ANALYSIS:

The students should know what the diameter of a circle is and how to estimate percentage in a circle graph.

PROCEDURE:

1. Preparation

   Duplicate Student Worksheet 2.3.

2. Steps in Lesson

   Objective: The students will be able to interpret diagrams of Arkansas sources of energy.

   a. Explain that in Arkansas in 1978 we obtained our primary energy from:

Oil	53.0%
Natural Gas	29.9%
Nuclear	7.3%
Coal	6.5%
Hydro	3.3%

   b. List the energy sources on the chalkboard and have the students draw a circle with a diameter of 4 inches and divide it in slices like a pie according to the sources of energy in the state.

   c. Distribute Student Worksheet 2.3 (Arkansas Gross Energy Consumption) and have students compare their circles they have just constructed with the one on the student worksheet. Have them complete the questions.

3. Evaluation

   a. Have the students list the three main primary energy sources used in Arkansas.

b. Distribute Student Worksheet 2.4 and have the students complete. Discuss with them.

4. Follow-Up Activities

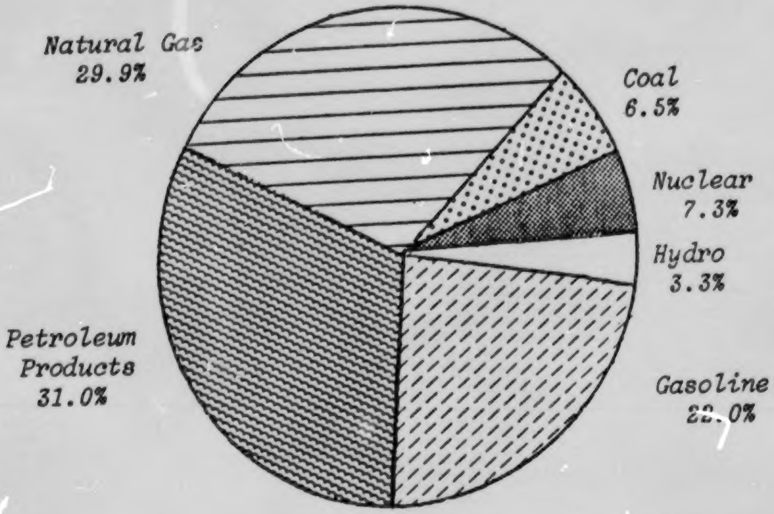
a. Have the students speculate on how we can use the energy from the sun to make electricity.

b. Demonstrate a solar cell (music box, toy).

ARKANSAS GROSS ENERGY CONSUMPTION

BY FUEL

1978



Total Gross Energy Consumption

761.22 Trillion BTU's

1. What per cent of energy does coal and nuclear provide Arkansas? ________

2. How much does Arkansas depend on oil (petroleum products and gasoline)?

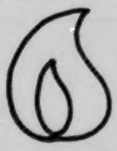
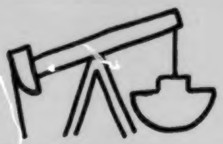
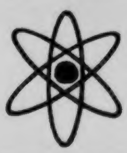
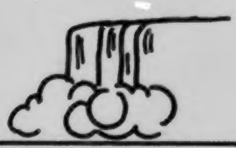
____

Source: Arkansas Energy Office

Student Worksheet

MATCH US

Directions: Match the pictures, words and percentage contributions of Arkansas' primary energy sources. Matching can be done via different color lines.

PICTURE	WORD	CONTRIBUTION
	COAL	29.9%
	NUCLEAR	6.5%
	NATURAL GAS	3.3%
	OIL	7.3%
	HYDRO	53.0%

LESSON #3

CATEGORY: Uses

ENERGY TYPE: Electricity

TITLE: What's a Watt?

GRADE LEVEL: 4-6

INFUSE WITH SUBJECT AREA:

TIME NEEDED: One period

Science, Math, Social Studies, Home Economics

MATERIALS:

40-, 60-, and 100-watt incandescent light bulbs

OBJECTIVE:

The students will discuss the way electricity is measured.

TASK ANALYSIS:

The students should be able to read directions and work in groups with other students.

PROCEDURE:

1. Preparation

   Duplicate Student Worksheets 3.2 and 3.3.

2. Steps in Lesson

   Objective: The students will discuss the way electricity is measured.

   a. Ask the students to name some ways they use electricity. List these on the chalkboard.

   b. Ask the students if they know what a watt is? (A unit of electrical power)
   Distribute Student Worksheet 3.2 (What's a Watt?) and have the students complete.

   c. Share the light bulbs with the students as you discuss the questions and answers to the completed Worksheet.

   d. Have the students complete Student Worksheet 3.3 (Light and Energy) at home and discuss the next day.

3. Evaluation

   Have the students write a paragraph explaining if a watt of electricity is useful. If so, why. If not, why not.

4. Follow-Up Activities

   Have the students count the number of light bulbs they use at home and what the wattage is of each one. Have them evaluate whether all that wattage is necessary. Have them determine how the wattage could be reduced.

Student Worksheet

What's a Watt?

Take a look at a light bulb.

What does the number on the end mean? This number tells the amount in watts of electricity the bulb will use in one hour.

1. A 60-watt bulb uses _____ watts of electricity in 1 hour.

2. A _____-watt bulb uses 40 watts of electricity in ___ hour.

3. A _____-watt bulb uses _____ watts of electricity in ___ hour.

4. How many watts of electricity will a 40-watt bulb use in two hours? __________

5. A 100-watt bulb will use ______________ of electricity in one hour. Your home uses many thousands of watts of electricity in one month. It is easier to measure the amount of electricity in a unit larger than the watt. One kilowatt = 1000 watts.

6. 500 watts equal __________ of a kilowatt.

7. 2 kilowatts equal ___________ watts.

8. How many kilowatts of electricity will four 500-watt bulbs use for one hour? _______________

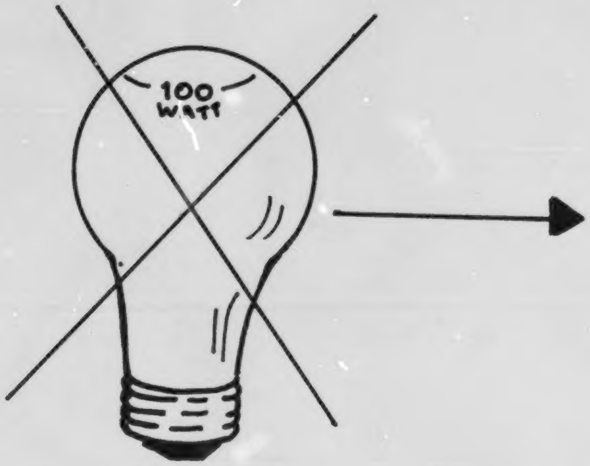
Student Worksheet

ANSWERS

1. 60
2. 40, 1 hour
3. (variable)
4. 80
5. 100 watts
6. 1/2
7. 2000
8. 2

Student Worksheet

LIGHT AND ENERGY



LIGHTING CHECKLIST TO SAVE ENERGY

_____Bulbs and lampshades free of dust and dirt?
_____Lampshades translucent (so light can pass through them) rather than solid?
_____Ceilings light-colored?
_____Walls light-colored?
_____"Non-critical" lighting levels kept as low as possible?
_____Does every member of your family turn off lights after he or she leaves a room?

NOTE: A light bulb consumes less energy during its starting stage than during a single second of normal operation! Always turn lights off when they are unnecessary, even for a few seconds.

LESSON #4

CATEGORY: Uses and Conservation

ENERGY TYPE: Electricity

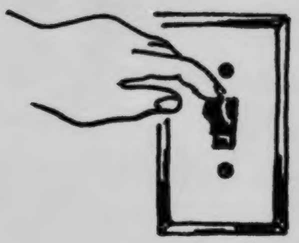
TITLE: Measuring and Saving Electricity

GRADE LEVEL: 4-6

INFUSE WITH SUBJECT AREAS:

TIME NEEDED: Two periods

Science
Social Studies
Math



MATERIALS:

None

OBJECTIVES:

1. The students will list ways they use electricity.
2. The students will learn how to read electric meters.

TASK ANALYSIS:

The students should be able to read directions and work with other students following instructions.

PROCEDURE:

1. Preparation

   Read Teacher Background Information (4.3 and 4.4).
   Duplicate Student Worksheets 4.5 and 4.6.
   Make a transparency of 4.4 or place the illustrations on the chalkboard.

2. Steps in Lesson

   Objective #1: The students will list ways they use electricity.

   a. Ask the students what do they use every day that is odorless, soundless, tasteless, and colorless? But as they use it they smell odors, hear sounds, taste things, and see various colors. (electricity)

   b. Ask them what is electricity? (the flow of electrons through a conductor from one place to another). Electricity has to be made (generated) to be useful; static electricity (lightning, etc.) is not useful electricity because it cannot be controlled.

   c. Elicit from the students the fact that they see the results of electricity. They will probably be able to tell you what electricity does rather than what it is.

   d. Distribute Student Worksheet 4.5 (Electricity: Who Needs It?) and have them complete.

   Objective #2: The students will learn how to read electric meters.

a. Ask the students: How do we know how much electricity we use?

b. Explain the method of reading an electrical meter to the students. Use a transparency of Teacher Background Information 4.4 or put the illustrations on the chalkboard.

c. Distribute Student Worksheet 4.6 (How Much Electricity Do We Use?) and have the students complete. Have them record the meter reading for day one and twenty-four hours later for day two. Subtract day one from day two to see how many kilowatts were used. Then have the students practice conservation. Have them record the reading for day three, save on their use of energy, and then record the meter reading for day 4. Subtract day three from day four. Compare the number of kilowatts used during each period of time.

d. Ask the students to assume each kilowatt cost 5 cents. How much money was saved over the second twenty-four-hour period of time? If they continue to conserve and save at least that number of kilowatts daily how much will be saved in a month? A year?

3. Evaluation

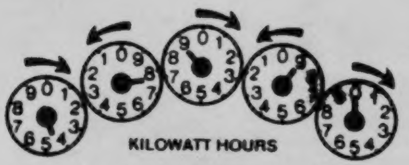
a. Challenge the students to imagine a day without electricity. Have them write a paragraph explaining how their day would be different if they had no electricity.

4. Follow-Up Activities

Urge each student to engage his/her family in seeing how much they can reduce their electricity usage. Record the readings on a weekly calendar. Students from families who saved the most can be asked to explain how they were so successful.

TEACHER BACKGROUND INFORMATION

Reading an electrical meter is easy once you know how to do it. Look at the illustration below. The dials are read in order from left to right. Notice on the five-dial-meter that the first, third and fifth hands turn clockwise and the second and fourth turn counterclockwise. If you have a four dial meter, the first and third turn counterclockwise and the second and fourth turn clockwise. When the indicator lies between two numbers, record the number the indicator just passed. It will always be the smaller number.



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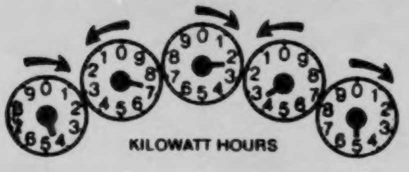
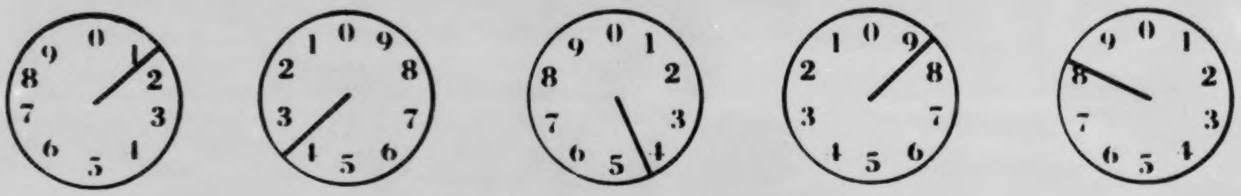
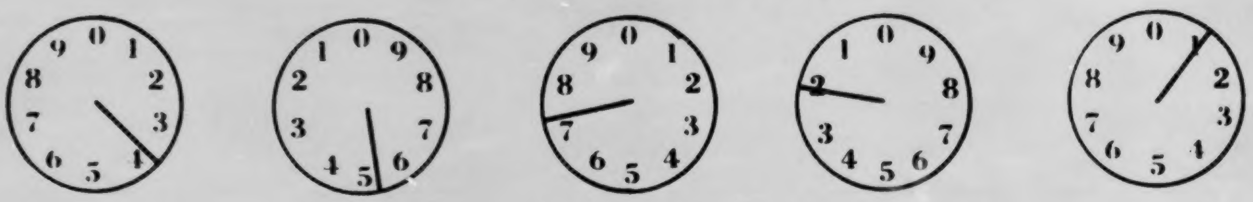


= (47,235)

READING AN ELECTRIC METER



READING = 13488



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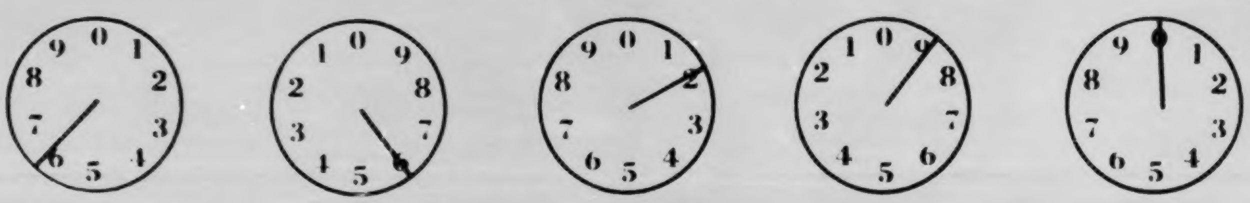


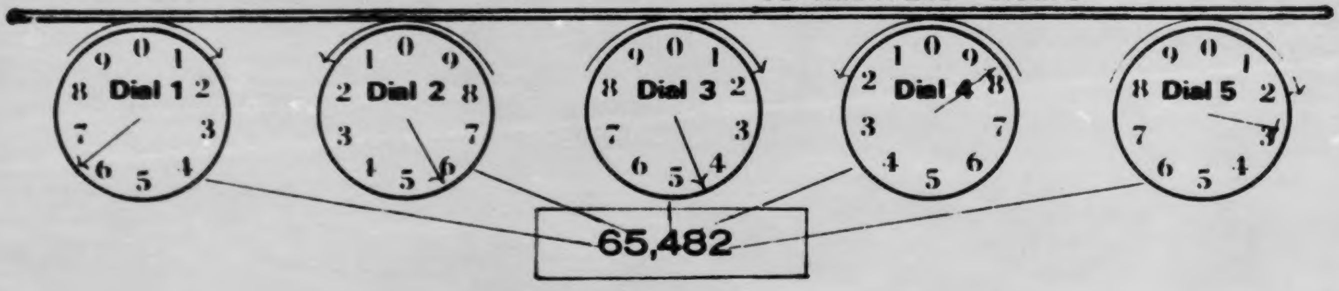
READING = 66190

Monday morning meter reads 13478

Tuesday morning meter reads 13488

How much has home consumed? 13488
-13478

10 kilowatt - hours



Student Worksheet

ELECTRICITY: WHO NEEDS IT?

Imagine a day that starts something like this. You roll over in your bed, open your eyes, and discover that the morning seems much brighter than it usually does at the start of your day. You check your alarm clock, but that turns out to be no help at all. It is stopped at 12:05. You know that's not right! You jump out of bed and bound into the kitchen. The battery-operated clock on the wall tells you that you have only 15 minutes to get to school--just enough time for a quick slice of toast and a cup of hot instant chocolate.

Before you go back to your room to get dressed, you pop a slice of bread into the toaster and turn on the electric range to boil some water. When you get back to the kitchen, you find that everything is exactly the way you left it--the bread is untoasted and the water is cold.

And that's only the beginning!

Suppose the electricity in your community has been shut off until further notice. And suppose everyone in your family is in good health and there is plenty of food in the house. You shouldn't have any problems. Right?

Well, without electricity how would you and your family:

Cook your food? ______________________________

Wash the dishes? ______________________________

Open a can? ______________________________

Make toast? ______________________________

Bake a cake? ______________________________

Store food in summer? ______________________________

Store food in winter? ______________________________

Wash the clothes? ______________________________

Keep warm in winter? ______________________________

Have light in your house? ______________________________

Entertain yourselves? ______________________________

Get to the 6th floor of a building? ______________________________

Get a weather report? ______________________________

Communicate with a friend across town? ______________________________

Source: United States Department of Energy

Student Worksheet

HOW MUCH ELECTRICITY DO WE USE?

Directions: Record your home electric meter reading for day one. Twenty four hours later record the reading for day two. Subtract the reading for day one from the reading for day two. How many kilowatts did you use in one day?

____

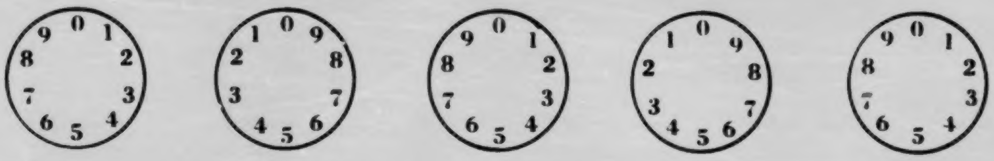
Repeat the same procedure for day 3 and day 4 while you practice energy saving. How many kilowatts did you use this time?______________

How does your use compare with that of other families?

Record the electricity used for one week.

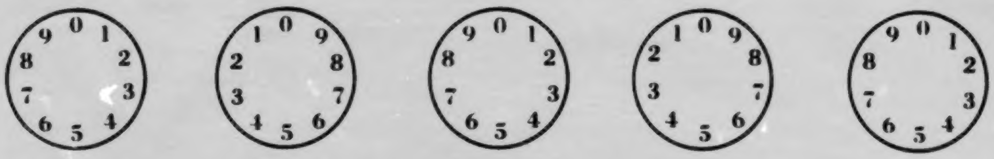
Check your family's electric bill to determine the cost of one kilowatt-hour (kwh). How much did one day's electricity cost?

Day 1



Date__________ **Time**__________ **READING** ________________

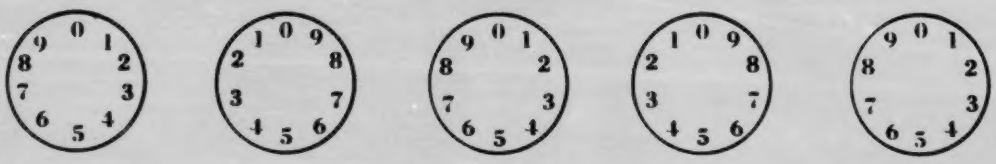
Day 2



Date__________ **Time**__________ **READING** ________________

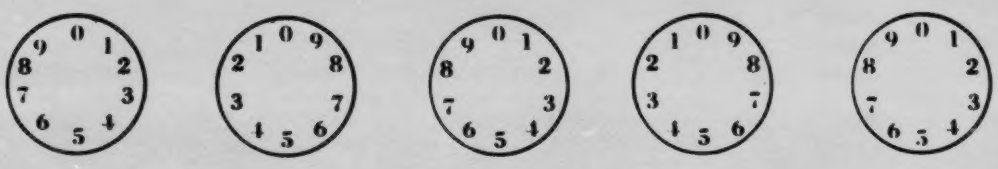
TRY TO SAVE ENERGY!

Day 3



Date__________ **Time**__________ **READING** ________________

Day 4



Date__________ **Time**__________ **READING**________________

LESSON #5

CATEGORY: Uses

ENERGY TYPE: Electricity

TITLE: Arkansas and Electricity

GRADE LEVEL: 4-6

TIME NEEDED: One period

INFUSE WITH SUBJECT AREA:
Social Studies
Math

MATERIALS:
None

OBJECTIVE:
The students will compare Arkansas' production and consumption of electrical energy with that of the United States.

TASK ANALYSIS:
The students should know what a circle graph is and be able to cut pieces of a circle out and to reassemble them.

PROCEDURE:

1. Preparation

   Read Teacher Background Information (5.2).
   Duplicate Student Worksheets 5.3 and 5.4.

2. Steps in Lesson

   Objective: The students will compare Arkansas' production and consumption of electrical energy with that of the United States.

   a. Have a "buzz" session with the students and find out their thoughts on where Arkansas gets the electricity that is needed.
   b. Distribute Student Worksheet 5.3 (Arkansas Sources of Energy for Electric Power Generation) and have the students cut the pieces out and fit together to make a circle.
   c. Discuss with the students the availability of electricity. Ask them if they know what segment of society consumes the most electricity in Arkansas.
   d. Distribute Student Worksheet 5.4 (Arkansas Electricity Consumption By Sector) and have the students cut out the pieces and reassemble to make a circle.
   e. Use the information in the Teacher Background Information and compare the use of electricity in the United States to that of the state of Arkansas and discuss with the students.

3. Evaluation
   Have the students recall what source of energy is used the most to produce electricity in Arkansas? Discuss with them what would happen if we could no longer rely on using that percentage.

4. Follow-Up Activities
   Divide the students into groups of two or three and have them think about and write what they think life in Arkansas was like seventy-five years ago when electricity was not so available.

Source:
Paul L. Butt. Arkansas and Energy. Arkansas Ecology Center: Little Rock. 1979.

From Oil and Natural Gas to Nuclear and Coal

The electric utilities in Arkansas represent both major energy users of primary energy resources and major suppliers of electrical energy to end-users. About 10 per cent of the total primary energy consumed in Arkansas is used in generating electricity which, in turn, supplies about 24 per cent of final end-use consumption. The per capita consumption of electricity in Arkansas is about 7500 kilowatt hours (KWH) per year as compared with a national average of about 8200 KWH.

In generating electricity, the fuel mix used by the Arkansas utilities is considerably atypical in comparison with the national average (Table below). The Arkansas energy inputs for electrical generation are considerably above national averages for oil and nuclear, and substantially below the national average for coal. The Arkansas mix will more closely reflect the nation's mix in the 1980's as coal-fueled power plants begin operating.

FUELS USED TO GENERATE ELECTRICITY

(as per cent of total)

Fuel	Arkansas	United States
Oil	42	16
Nuclear	32	14
Hydro	17	10
Natural Gas	10	12
Coal	*	48

Note: Arkansas percentages add up to 101 due to rounding.

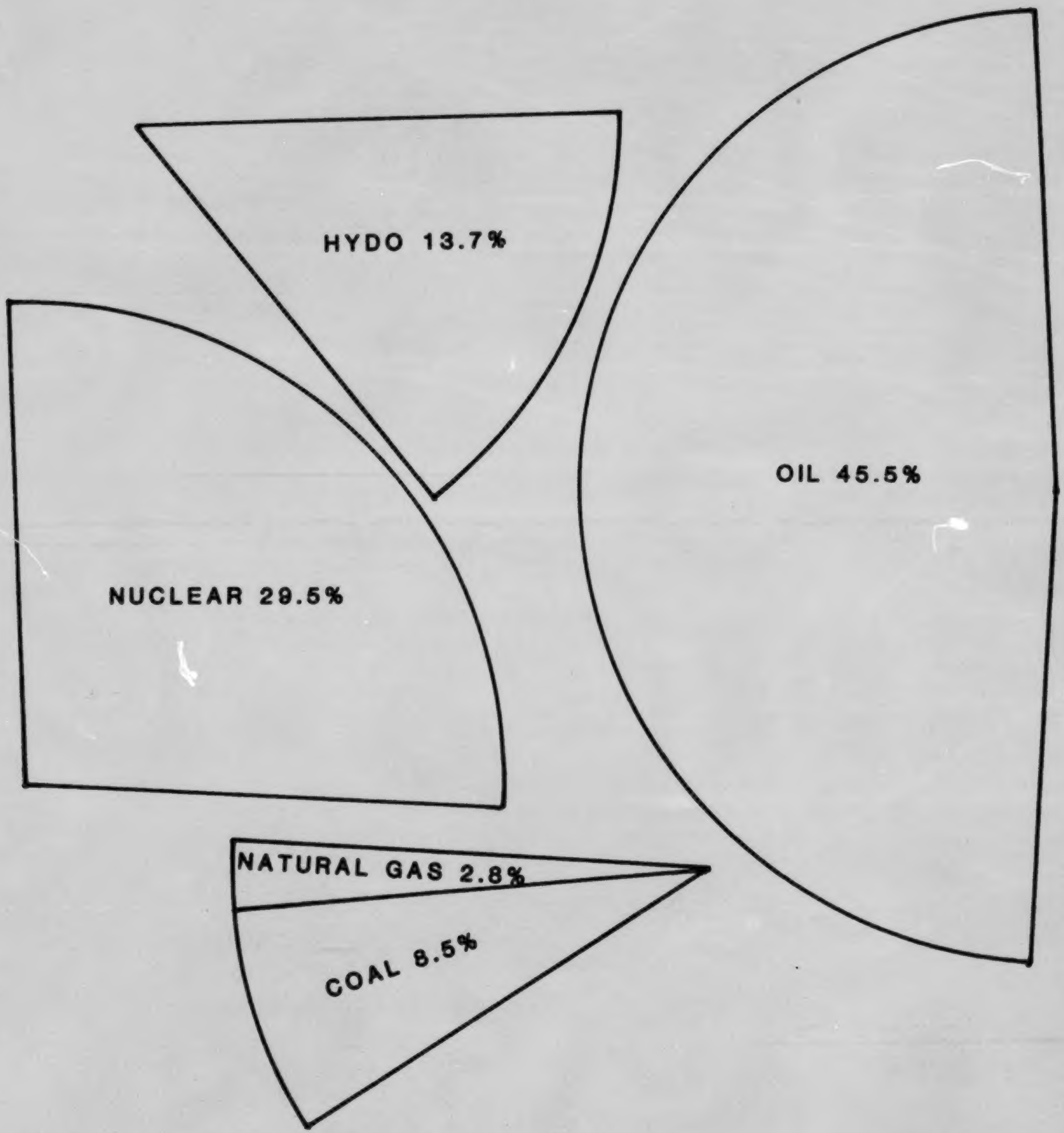
*1979 was the first year in a while that there was coal-fueled electrical generation in Arkansas. In the 1980's, at least two additional coal-fueled power plants are projected to become operational in the state. Thus, the percentage of coal-fueled electrical generation in Arkansas will increase in the future.

Student Worksheet

ARKANSAS SOURCES OF ENERGY

FOR ELECTRIC POWER GENERATION

1978



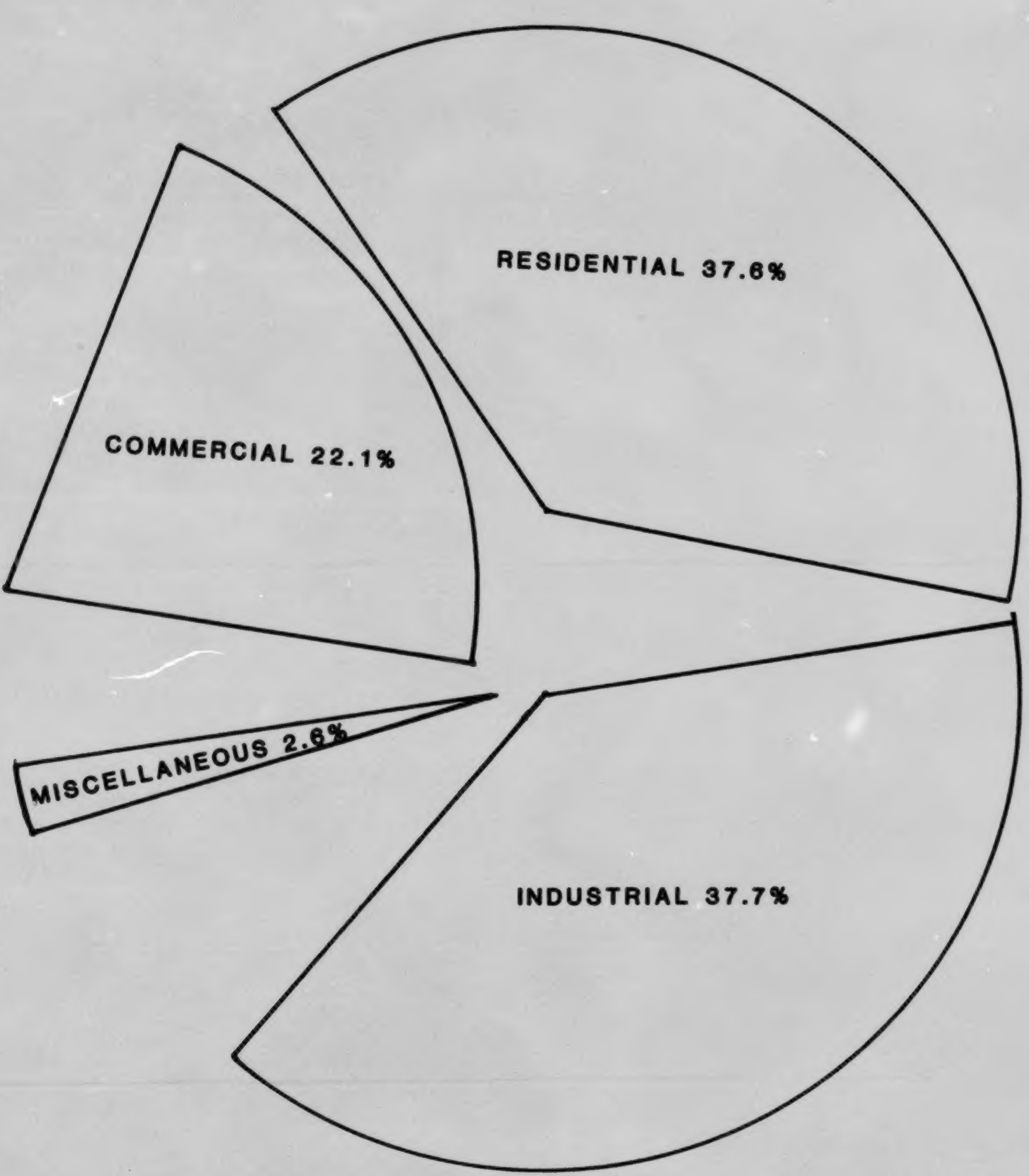
DIRECTIONS: Cut each section out and reassemble into circle.

Student Worksheet

ARKANSAS ELECTRICITY CONSUMPTION

BY SECTOR

1978



DIRECTIONS: Cut each section out and reassemble into circle.

36

LESSON #6

CATEGORY: Conservation

ENERGY TYPE: All

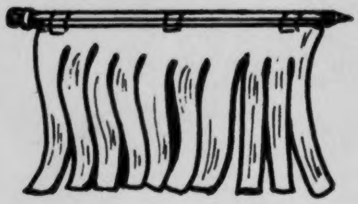
TITLE: U CAN S.A.V.E. (Save Arkansas' Vital Energy): Stop the Draft

GRADE LEVEL: 4-6

TIME NEEDED: Two periods

INFUSE WITH SUBJECT AREA:

Science
Math
Language Arts
Home Economics



MATERIALS:

Facial tissue
Tape
Stick
Pencil or dowel (12 cm long) for each student

OBJECTIVE:

The students will be able to determine when an air draft is present in a room.

TASK ANALYSIS:

The students should be able to follow oral instructions to construct equipment needed for an experiment; and be able to work together in small groups and express their thoughts in a paragraph.

PROCEDURE:

1. Preparation

   Read Teacher Background Information (6.3).
   Construct a draft-o-meter to use as an example (see above sketch).

2. Steps in Lesson

   Objective: The students will be able to determine when an air draft is present in a room.

   a. Introduce the vocabulary words

      1. Draft - the process by which outdoor air leaks into a building by natural forces, especially through cracks around doors and windows

      2. Weatherstripping - foam, metal, or rubber strips used to form a seal around windows, doors, or openings to reduce drafts

      3. Caulk - paste type substance used to form a seal around windows, doors, or openings to reduce drafts

b. Gather necessary materials to make the draft-o-meter. Let the students work in pairs. Give oral instrucitons for constructing a draft-o-meter.

  - Have each student tape on facial tissue lengthwise to the 12 cm stick, pencil or dowel; cut the facial tissue into strips to within 2 cm of the stick, pencil or dowel.

  - Demonstrate when a little waving is evident and when a lot of waving is evident.

c. Assign students to different areas of the school to check the doors and windows for air leakage. Have them record whether there is a little or a lot of waving of the draft-o-meter.

NOTE: Forced air furnaces must be off when using the draft-o-meter.

d. Reassemble and discuss with the students why drafts are energy wasters and what can be done to correct these drafts. (weatherstripping windows and doors; caulking cracks that provide air leaks)

e. Have the students take the draft-o-meters home and test for drafts. Encourage the students to test their fireplaces, if they have one, with the damper open and closed and note the results.

f. Conduct a classroom discussion after using the draft-o-meter at home. Comparisons will become obvious and feelings of students can be protected if discussions deal in generalities and not with specifics.

3. Evaluation

a. Have the students use index cards to write the vocabulary words on and use as flash cards to test other students.

b. Invite the principal and custodian to the classroom to learn of the students' survey of drafts in the school. Have the principal and custodian tell the students what energy conservation measures they are taking and how they can involve the students in this endeavor.

c. Have the students write a paragraph explaining how drafts affect heating and cooling of their homes and the anticipated results if they are involved in the weatherstripping and caulking of the drafts.

4. Follow-Up Activities

Have the students check some hardware stores and lumber yards to determine what kinds of materials are sold to insulate homes.

Stop the Draft

Some estimates indicate as much as 10 to 25 per cent of one's fuel dollar is lost through cracks. Weatherstripping windows and doors and caulking cracks that provide air leaks can prevent this loss. Most weatherstripping is relatively inexpensive and easy to install by the homeowner.

Tight fitting storm doors and windows can reduce heating bills by almost 15 per cent, and prevent drafty rooms. Take advantage of the sun's heat. Let the sunlight warm the house during the day by keeping the drapes open. Then shut the drapes at night to retain the heat.

LESSON #7

CATEGORY: Conservation

ENERGY TYPE: Electricity

TITLE: U CAN S.A.V.E. (Save Arkansas' Vital Energy): Lighting

GRADE LEVELS: 5-6

INFUSE WITH SUBJECT AREA:

TIME NEEDED: Two periods

Home Economics
Math
Language Arts

MATERIALS:

Several empty fluorescent light bulb packages
Several empty incandescent light bulb packages

OBJECTIVE:

The students will compare the energy efficiency of fluorescent and incandescent light bulbs.

TASK ANALYSIS:

The students should be able to increase their vocabulary as needed to read and understand the worksheets and information on the light bulb packages, and divide whole numbers.

PROCEDURE:

1. Preparation

   Read Teacher Background Information (7.3).
   Duplicate Student Worksheets 7.4, 7.5 and 7.6.
   Collect several empty fluorescent and incandescent light bulb boxes.
   List vocabulary words on chalkboard.
   Inform others in the school that students will be conducting a survey.

2. Steps in Lesson

   Objective: The students will compare the energy efficiency of fluorescent and incandescent light bulbs.

   a. Discuss the vocabulary words and definitions:

      Efficiency - ratio of useful lighting to total energy input

      Conservation - care or preservation of all natural resources

      Fluorescent lamp - a tubular electric lamp having a coating of flourescent material in its inner surface

      Incandescent lamp - an electric lamp in which a filament gives off light when heated

      Consumer - a user of goods and services

Lumens - amount of light a bulb gives

Wattage - amount of electricity needed to operate a light bulb

Let the students work in groups of two or three and write their own definitions.

b. Have the students study, discuss, and complete Students Worksheet 7.4 (Fluorescent vs. Incandescent Lighting).

c. Distribute Student Worksheet 7.5 (School Lighting Survey). Stress the fact that the students are engineers on assignment and they must not interrupt other classes in session. After the Worksheet is completed, reassemble, discuss, and fill in the gaps with necessary data.

d. Invite the principal and/or custodian to participate by discussing energy conservation measures at school.

3. Evaluation

Have the students define in writing incandescent and fluorescent lighting, tell which they prefer, and justify their choice.

4. Follow-Up Activities

a. Have the students do Student Worksheet 7.6 (Home Lighting Survey) and discuss incandescent and fluorescent lighting with their parents.

b. **ENCOURAGE STUDENTS TO TURN OFF LIGHTS WHEN NOT IN USE.**

LIGHTING

Source:
Tenneco, Inc. SEED (Schoolhouse Energy Efficiency Demonstration). Tenneco, Inc.: Houston.

The purpose of this lesson is to develop an energy awareness about lighting. The problems with lighting fall into several categories: the use of inefficient types of lights, the use of too much artificial light and poor quality lighting.

It is widely known that incandescent lamps use more energy and last a shorter time than standard fluorescent lamps.

The following table is a comparison of the two types of lighting:

	COST	RELATIVE EFFICIENCY	EXPECTED LIFE (in hours)	COLOR QUALITY
Incandescent	Low	1	1,000	Good
Fluorescent	Moderate	4	20,000	Good

Student Worksheet

FLUORESCENT VS. INCANDESCENT LIGHTING

WATTAGE tells us how much power (energy/time) is needed to operate a light bulb. It is **NOT** a measure of the amount of light given by the bulb.

The amount of light a bulb provides is measured in **LUMENS**. You can find this information on the package the bulb comes in.

Example: A 100-watt incandescent bulb may give 1750 lumens. Take the number of lumens and divide the wattage amount into it.

1750 lumens/100 watts equals 17.5 lumens per watt

1. A 100 watt fluorescent bulb: ________ lumens per 100 watts equals _________ lumens per watt.

2. A 40 watt fluorescent bulb: ________________ lumens per 40 watts equals _______lumens per watt.

3. A 100 watt incandescent bulb: ______________ lumens per 100 watt equals _______lumens per watt.

4. A 40 watt incandescent bulb: ________ lumens per 40 watt equals _________ lumens per watt.

5. Which type of bulb appears more efficient? ____________

6. Now that you know that a 100-watt fluorescent bulb gives off _______ lumens per watt and a 100-watt incandescent gives off _________ lumens per watt, which do you think would save the most watts of electricity over an eight hour period of time _______________. How many watts? ____

Student Worksheet

SCHOOL LIGHTING SURVEY

As an engineer you are reminded that when you look at lighting efficiency you must remember to notice:

1. Inefficient types of lights
2. The use of too much artificial light
3. Poor quality lighting

1. How does the color of the walls affect lighting?

2. List any areas of the school where you think there are unnecessary lights?

3. List any rooms where the lights appear too bright?

4. List any areas where lights appear too dim?

5. Does your school use energy-efficient fluorescent lamps?

6. Are there areas where lights have been left on when no one was present?

7. Is the natural light from windows used properly?

8. Unscramble the words and answer this statement: When you leave the room be sure to URNT FFO LITGHS.

Student Worksheet

HOME LIGHTING SURVEY

Check to see if:

1. Light bulbs are free of dust and dirt.
2. Lampshades are free of dust and dirt.
3. Lights for reading are concentrated.
4. Lights for work areas are located in a central place.
5. Ceilings are light-colored.
6. Walls are light-colored.
7. Lower wattage lights in halls.
8. Lights are turned off when not in use.

Just for fun:
What did Energy Ant say to the light bulb?
(Socket to me)

What did the light bulb say to the light switch?
(Are we going out tonight?)

LESSON #8

CATEGORY: Conservation

ENERGY TYPE: All

TITLE: U CAN S.A.V.E. (Save Arkansas' Vital Energy): Choices

GRADE LEVEL: 4-6

INFUSE WITH SUBJECT AREA:

TIME NEEDED: One period

Consumer Education

MATERIALS:

Colored pencils (red and green)

OBJECTIVE:

The students will make conservation choices between two alternative energy uses.

TASK ANALYSIS:

The students should be able to work together, listen to others and make decisions.

PROCEDURE:

1. Preparation

   Read Teacher Background Information (8.3).
   Duplicate Student Worksheets 8.5, 8.6, and 8.7.
   Collect magazines and newspapers to be cut up.
   Note bulletin board suggestions on 8.4.

2. Steps in Lesson

   Objective: The students will make conservation choices between two alternative energy uses.

   a. Distribute Student Worksheet 8.5 (Operation Observation) and have the students complete. Discuss their general awareness of energy.

   b. Distribute Student Worksheet 8.6 (Energy: Waste or Save?). Ask the students to discuss with each other the blocks before they color them. They are to explain their choices to the other class memebers and if there is a difference of opinion they are to justify their color to the satisfaction of others in the class.

   c. Divide the students into groups of four or five students and distribute Student Worksheet 8.7 (Decision Time). Encourage them to study, discuss, and then state their reasons for their decision. A Discussion Guide follows the Student Worksheet to help you, the teacher, guide a discussion. Let the groups compare their choices and discuss the possible impacts.

3. Evaluation

   a. Have the students prepare a collage of energy conservation advertisements from magazines, newspapers, etc.

   b. Debate: Resolve: My folks are conserving in the use of our car. Will I have to give up my music lessons, little league practices and games, choir practice, etc.? (Any event that is important to the student.)

4. Follow-Up Activities

Have the students design and write advertisements for some of the choices they made on Student Worksheet 8.7 (Decision Time).

TEACHER BACKGROUND INFORMATION

Source: Tom Redburn. The Energy Puzzle: How You Fit In. United States Department of Energy: Washington, D.C. 1979.

Conservation is America's and Arkansas' greatest untapped energy source. Every barrel of oil saved represents a quantity of costly foreign oil that will not have to be imported. Every action to improve the efficiency with which energy is used is, in effect, a step toward the production of additional energy. And given the tremendous waste that has been built into our industrial society by decades of cheap oil, conservation is the least expensive, safest, and quickest available energy source.

"If the United States were to make a serious commitment to conservation, it might well consume 30 to 40 per cent less energy than it now does," argues Daniel Yergin, co-editor of Energy Future, a book based on a six year study at the Harvard Business School, "and still enjoy the same or an even higher standard of living.

Conservation, of course, will not eliminate the need to develop other new sources of enery. But given the challenges thrown up by the energy crisis, its potential is enticing. As Mr. Yergin has asked, "Which is cheaper--a barrel of new production in some distant and hostile terrain, with the risk of a dramatic increase in price, or a barrel saved by insulation?"

Bulletin Board Suggestions:

What have ***you*** done ***today*** to ***save energy?***

Necessity is the mother of conservation and the father of efficiency
—William Anderson, Headquarters

Use YOUR energy to SAVE energy
—Sherry Harris, Portland

Conservation diet: Waste Watchers
—Dave Barnes, Des Moines, Iowa

The energy you save may be you own

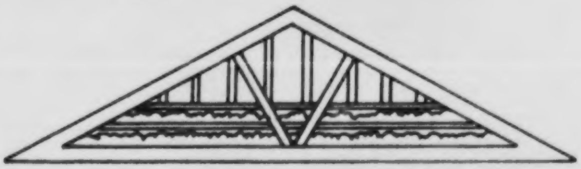
Student Worksheet

OPERATION OBSERVATION

How well do you know the house or apartment where you live? How many windows in your bedroom? How many doors to the outside of the house? What fuel do you use to heat with? Try to answer these questions now; then check when you go home to see if you were correct. This sheet will help you and your family learn more about your own dwelling as a first step toward home energy conservation. With the help of a parent, answer the following questions; then discuss what conservation measures your family can take.

GENERAL INFORMATION

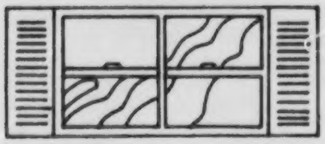
1. How many levels is your house? ☐ one story; ☐ split level; ☐ two stories; ☐ three or more stories.
2. What fuel do you use in your heating system? ☐ Natural gas ☐ electricity; ☐ oil; ☐ coal; ☐ kerosene; ☐ propane.
3. When was your heating system last cleaned and serviced? ______
4. What fuel do you use for cooking? ______
5. For heating water? ______
6. For drying clothes? ______
7. Is your home air-conditioned? ______
8. Where do you set your thermostat in the winter during the daytime? ☐ 65° or less; ☐ 65° to 68°; ☐ 69° to 72°; ☐ 73° to 75°; ☐ above 75°.
9. Where is it set at night? ______



ATTIC

1. Do you have an attic or crawl space in your apartment or house? ______
2. Is the attic floor insulated? ______
3. How many inches of insulation are on the attic floor? ______
4. What does the insulation look like (loose, blanket)?

______

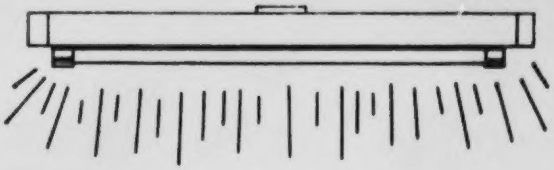


WINDOWS AND DOORS

1. How many windows? ______ How many doors? ______
2. How many have storms or double-glazing?

______

3. Do any of your windows rattle when the wind blows? How many?
4. On a cold or windy day can you feel cold air near your windows or doors even when they are closed?
5. Is there weatherstripping around your doors?



LIGHTING

1. How many rooms are lighted with fluorescent bulbs?

______

2. How many incandescent bulbs per room? ______

APPLIANCES

1. TV: How many? ______ B&W ______ Color ______
2. Refrigerator: ______ Frostfree ______ Regular
3. Oven: ______ Self-cleaning ______ Regular ______ ______ Microwave
4. Water heater: ______ Size ______ Temperature setting

REMEMBER: You can save up to half of the fuel used to heat and cool your house if it is airtight! So . . . insulate; install storm windows (a sheet of clear heavy plastic tightly taped to window and door frames will do the job almost as well as glass); caulk or weatherstrip where necessary; use draperies; and reset thermostat settings on furnace and water heater, if change is needed.

Source: United States Department of Energy

Student Worksheet

ENERGY: WASTE OR SAVE?

Dripping hot water faucet	Room with thermostat set at 68 or lower	Lights on in an unoccupied room	Electric Can Opener	Car making jack rabbit start	Washing machine with cold water only
Growing A Garden	Clean Filters--Car and/or furnace	Doors and windows closed in cold weather	Car coasting to a smooth stop	TV off when no one watching	Carpool or Vanpool
Public building over 65 in winter	Fluorescent lights rather than incandescent	Outside lights burning during the day	Insulation	Car carrying only the driver	Taking showers instead of baths
Car coming to a quick stop	Wearing sweaters and warm clothing in winter	Using bicycle instead of car	Electric toothbrush in use	People walking to work or school	Car speeding over 55 mph
Sun allowed to shine into home to give warmth in winter	Ceiling Fan --winter or summer	Door or window open with heat or air conditioning on	Full loads in the washing machine	Room with thermostat below 78 in summer	Using china instead of paper plates
Car idling over 60 seconds	Lights off when no one using them	Electric knife in use	House with storm windows and doors	Clothes hanging out to dry	Recycling of paper, glass, metal

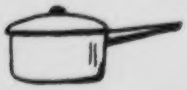
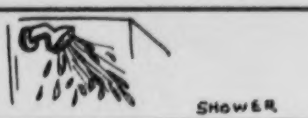
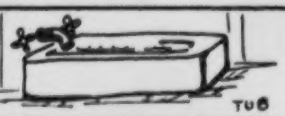
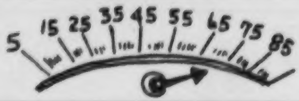
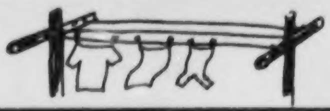
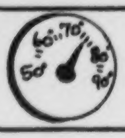
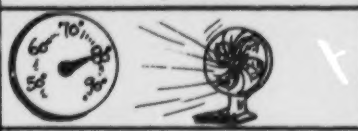
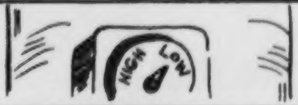
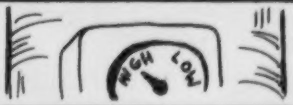
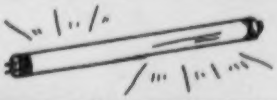
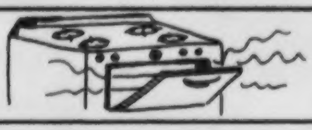
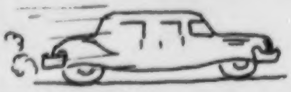
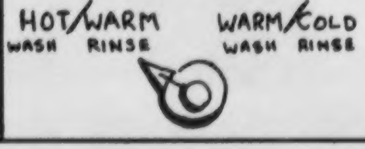
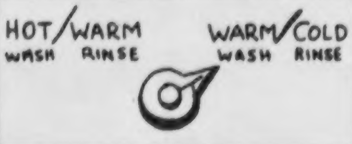
DIRECTIONS:

1. Color the blocks red which show a waste of energy.

2. Color the blocks green which show a saving of energy.

Student Worksheet

DECISION TIME

DESCRIPTION	THIS? OR	THIS?	WHY?
BOILING WATER			
BATHING			
DRIVING			
DRYING CLOTHES			
COOLING SPACE			
HEATING WATER			
CLEANING			
DRYING HANDS			
LIGHTING			
TOASTING BREAD			
RUNNING ERRANDS			
CLEANING CLOTHES	 HOT/WARM WASH RINSE WARM/COLD WASH RINSE	 HOT/WARM WASH RINSE WARM/COLD WASH RINSE	

Student Worksheet

DECISION TIME

(Discussion Guide for Teachers)

Boiling Water		Water will come to a boil faster and use less energy in a covered pan.
Bathing	A shower with a flow of 4 gallons of water a minute uses only 20 gallons in 5 minutes.	It takes about 30 gallons of water to fill the average tub.
Driving	Most automobiles get about 20 per cent more miles per gallon on the highway at 55 mph than they do at 70 mph.	
Running Errands		
Drying Clothes	As a bonus, clothes dried outside often seem fresher and cleaner.	
Cooling Space		If used with window air conditioner spreads cooled air farther without greatly increasing power used.
Heating Water		Uses more energy than any other appliance in a house.
Cleaning		
Drying Hands		
Lighting	Fluorescent lights give out more lumens per watt.	
Toasting Bread		Uses only one-third the energy of toasting in an oven.
Cleaning Clothes	Takes about 35 gallons of water to do a full load. Changing the rinse water to cold, which experts say does not affect the results, and lowering the wash setting from hot to warm will make a big saving.	

LESSON #9

CATEGORY: Sources

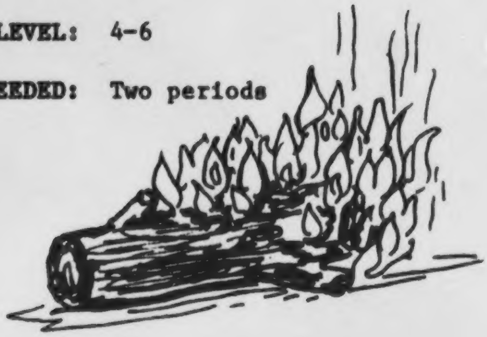
ENERGY TYPE: Wood

TITLE: Back to the Woods

GRADE LEVEL: 4-6

INFUSE WITH SUBJECT AREA:

TIME NEEDED: Two periods



Social Studies
Language Arts

MATERIALS:

None

OBJECTIVE:

The students will be able to state reasons why earlier Arkansans relied on wood as their source of fuel.

TASK ANALYSIS:

The students should be able to work in small groups and accurately infer from pictures.

PROCEDURE:

1. Preparation

   Read Teacher Background Information (9.3).
   Duplicate Student Worksheets 9.4, 9.5, and 9.6.

2. Steps in Lesson

   Objective: The students will be able to state reasons why earlier Arkansans relied on wood as their source of fuel.

   a. Distribute Student Worksheet 9.4 (Energy and Living Patterns: The Arkansas Pioneer Homestead) and Student Worksheet 9.5 (The Arkansas Pioneer Homestead). Have the students infer from the picture the answers to the questions.

   b. Discuss with the students the availability of wood as an energy source and the idea that many early Americans would just move farther west as their wood source was depleted.

   c. Have the students write at least five rules that would apply to woodburning in the days of pioneer Arkansans and present-day Arkansans.
      - Care in cutting
      - Know where tree is to fall
      - Consider installation safety for floors, fixture, ceiling, attic, roof and chimney
      - Never use gasoline to start a fire in a wood stove
      - Check for creosote buildup (especially if burning pine or cedar)
      - Clean flue or chimney as needed
      - Store wood in an accessible location
      - Keep stored wood off ground
      - Keep stored wood covered

d. Distribute Student Worksheet 9.6 (Sources of Firewood) and have the students answer the questions concerning the poem. Then have the students compare the heating value of ash and oak, both approved by the poet, with the Firewood Heat Values chart on the page. You may want to explain to the students that BTU is an abbreviation for British Thermal Unit. It is a standard unit for measurement of the amount of heat energy needed to raise the temperature of one pound of water one degree Fahrenheit.

3. Evaluation

a. Have the students write advertisements that might have appeared in pioneering Arkansas' newspapers seeking labor to cut firewood, selling a cord of wood, and selling a woodburning heater.

b. Have the students write directions on "How to Carry Wood" inside the house from the wood shed.

4. Follow-Up Activities

Ask the students to look up chimney sweepers in the phone book yellow pages and investigate to see how long these businesses have been operating and if their business has increased in the last few years.

TEACHER BACKGROUND INFORMATION

Presently in Arkansas, wood and wood waste are commonly used for primary and auxiliary heating needs. As fossil fuel prices have risen, there has been a rebirth of interest in the wood-burning stove. Fortunately, wood-burning stoves have been made extremely efficient and they are in great demand. Some Arkansans, especially those in rural areas, never abandoned wood as a source of heat. As late as 1950 about two-thirds of Arkansas counties used wood as the primary home heating source. In 1970 this was still the case in Marion, Newton, and Searcy counties. The Arkansas Department of Energy states that preliminary data estimates wood consumption in Arkansas in 1978 at approximately 360,000 cords. A cord is four feet wide, four feet high by eight feet long or 128 cubic feet. For comparison, this is the equivalent of about one-third of the propane used in Arkansas the same year.

The work involved in preparing firewood - chopping, sawing, splitting, hauling, stacking, and protecting it from the elements - can be an exhilarating or exhausting experience. The traditional way of putting up cordwood is to cut a tree down and into four-foot-long sections during the fall and winter months, leave it to age over the coming summer, and then put it in the woodshed the following fall for use.

The woodburning process is more or less the photosynthesis process in reverse. It is called combustion or rapid oxidation. All the moisture present must be turned to steam and eliminated before the wood can ignite. Then after the volatile oils vaporize and burn, the combustion of the coals takes place.

Student Worksheet

ENERGY AND LIVING PATTERNS:
THE ARKANSAS PIONEER HOMESTEAD

1. What sources of energy were available to the settlers?

2. Show how the following tasks were done by the settlers. What energy was used in these tasks?

   a. Producing food

   b. Preparing food

   c. Building homes and barns

   d. Lighting and heating homes

   e. Preparing clothing

   f. Making furniture

3. List two jobs performed by each member of the family.

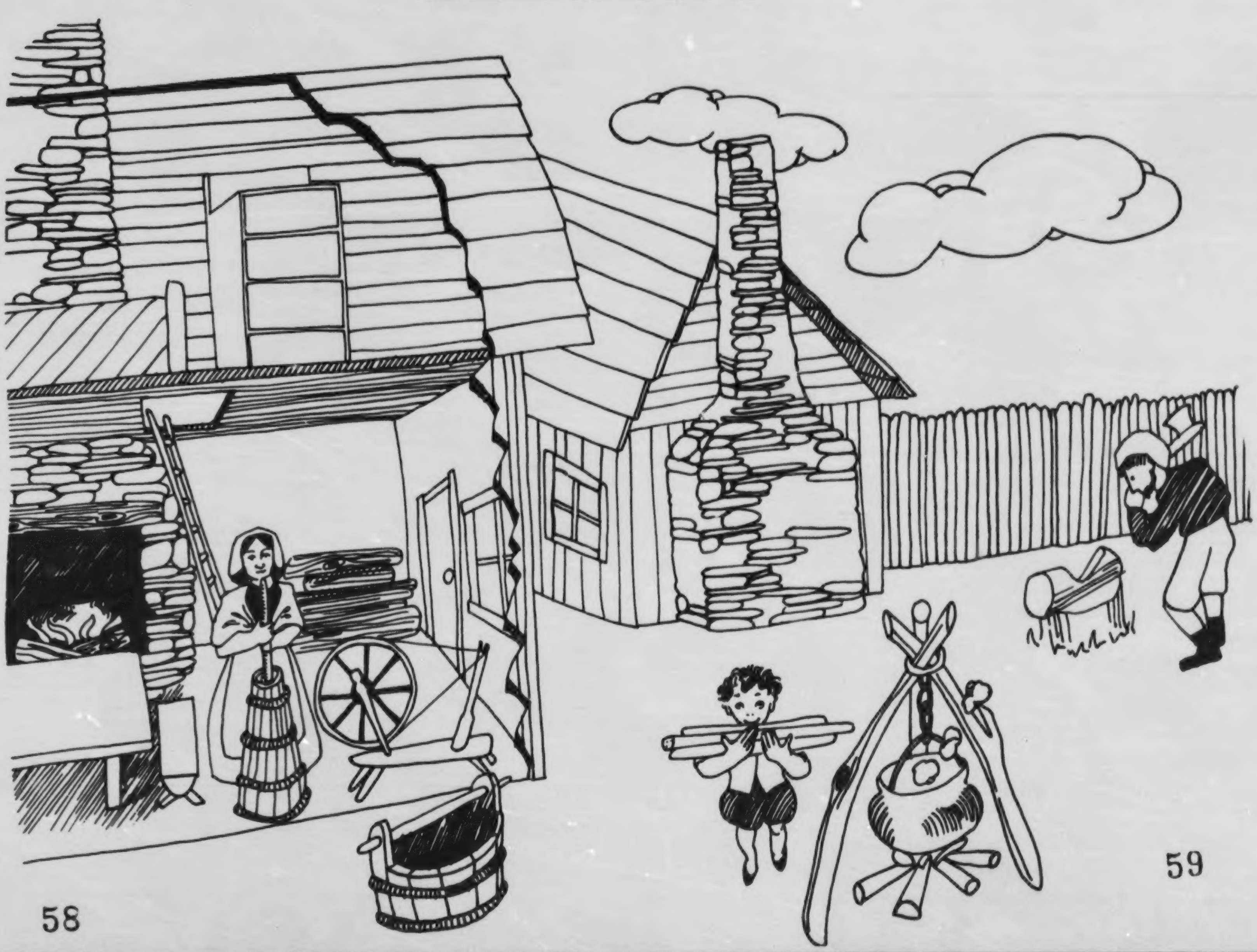
   a. Mother

   b. Father

   c. Children

4. In the pioneering period, what made one family wealthier or better off than another?

THE ARKANSAS PIONEER HOMESTEAD



Student Worksheet

9.5

Student Worksheet

SOURCES OF FIREWOOD

Directions: Read the poem and answer the questions. Compare the heating value of ash and oak with the Firewood Heat Values chart.

Beechwood fires are bright and clear
If the logs are kept a year.
Chestnut's only good they say,
If for long 'tis laid away.
But ash new or ash old
Is fit for queen with crown of gold.

Birch and fir logs burn too fast,
Blaze up bright and do not last.
It is by the Irish said
Hawthorn bakes the sweetest bread.
Elmwood burns like churchyard mold,
E'en the very flames are cold.
But ash green or ash brown
Is fit for queen with golden crown.

Poplar gives a bitter smoke
Fills your eyes and makes you choke.
Apple wood will scent your room
With an incense like perfume.
Oaken logs, if dry and old,
Keep away the winter's cold.
But ash wet or ash dry
A king shall warm his slippers by.

Anonymous English Poet

Questions:

1. Should firewood be cut just before it is burned? _____ If not, how long before you need it should it be cut? _________
2. The poet mentions one type of wood that is good when baking bread, what is it? __________ Do we have this tree in Arkansas? ___________
3. Which woods burn too fast? _______________________
4. The smoke from most wood will cause us to tear but the English poet mentions a specific tree, what is it? ________________
5. What wood is best for heating purposes according to this poem? ________ Do we have this tree in Arkansas? _______

FIREWOOD HEAT VALUES

	Million BTU's/Cord		# Cords to produce 70 million BTU's for wood heat
	Green (100% M.C.)	Air Dry (20% M.C.)	
Cottonwood	10.0	12.4	5.0
Elm	14.3	17.2	4.0
Pine	14.6	18.0	3.9
Hackberry	15.1	18.8	3.7
Ash	16.5	20.0	3.5
Red Oak Group	17.9	21.3	3.3
Hawthorn	18.3	22.7	3.1
White Oak Group	18.4	22.7	3.1
Mulberry	18.6	23.0	3.0
Black Locust	19.7	24.4	2.8
Hickory Group	20.7	24.6	2.8
Osage Orange	22.9	28.3	2.5

M.C. = moisture content

Regardless of the species you prefer, obtain your firewood one season before burning. It takes at least 6 months for most wood to dry to a 20% moisture content.

LESSON #10

CATEGORY: Sources

ENERGY TYPE: Geothermal

TITLE: Heat Beneath Our Feet

GRADE LEVEL: 4-6

INFUSE WITH SUBJECT AREA:

TIME NEEDED: Two periods

Science
Social Studies

MATERIALS:

World wall map
Stove or hot plate
Tea kettle
Potato
Plastic spoons (8)
Pencil
Cookie sheet
Damp towel
Pan

OBJECTIVES:

1. The students will recognize geothermal energy as an alternative energy source.

2. The students will locate on a map the areas where geothermal energy is now being used.

TASK ANALYSIS:

The students should be able to follow oral and written directions, work in small groups and use maps successfully.

PROCEDURE:

1. Preparation

   Read Teacher Background Information (10.4 and 10.5).
   Duplicate Student Worksheets 10.6, 10.8, 10.9, and 10.10.
   Obtain world wall map.
   Make transparency of Student Worksheet 10.9 or place the diagram on the chalkboard.

2. Steps in Lesson

   Objective #1: The students will recognize geothermal energy as an alternative energy source.

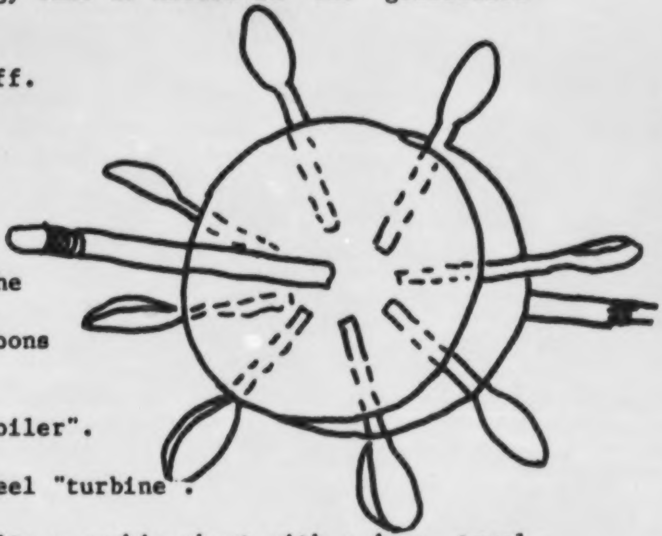
   Objective #2: The students will locate on a map the areas where geothermal energy is now being used.

   a. Ask the students what the word "geothermal" means? (geo - meaning earth; thermal - having to do with heat, hot springs; geothermal - source of heat from inside the earth)

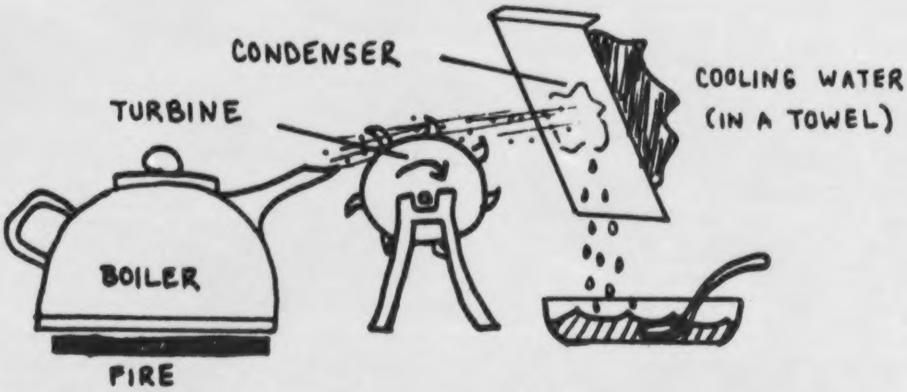
b. Ask the students what is geothermal energy? (heat radiates constantly from the earth's core, sometimes concentrating in local hot spots near the surface; consequently when underground water meets naturally heated underground rocks, steam results and rises to the surface)

c. Distribute Student Worksheet 10.6 (Geothermal Energy Reading Sheet). Have students read it silently and then discuss the information with each other.

d. Relate geothermal steam to the energy that is needed in the generation of electric power.



- Take a potato and cut both ends off. The center slice should be about 1 1/2 inches wide.
- Place a pencil through the middle for an axle.
- Take 8 plastic spoons and stick the handles into the potato almost to the pencil. Make sure all the spoons are turned the same way.
- Heat the water in a tea kettle "boiler".
- The steam will turn the potato wheel "turbine".
- The steam will condense when it hits a cookie sheet with a damp towel held against it.
- The condensed water will drip into the pan to be returned to the boiler and recycled (used again).
- Turn the fire off.



e. Discuss with the students how geothermal energy is used:

- Recreation/therapeutic - examples: Hot Springs, Arkansas; Glenwood Springs, Colorado. (the use of hot springs for baths dates to ancient times)
- Heating buildings - examples: Klamath Falls, Oregon; Boise, Idaho; Reykjavik, Iceland; and Rotorua, New Zealand
- Processing food and other consumer goods - example: Klamath Falls, Oregon
- Generating electricity - examples: The Geysers, California; Lardello, Italy; and Cerro Prieto, Mexico

f. Divide the class into eight groups and give each group one of the Student Worksheet 10.7 (Accounts of Geothermal Uses). Have the students locate the places on the world map by placing a tack at each source being used. Let each group tell of its account of geothermal energy being used.

3. Evaluation

a. Distribute Student Worksheet 10.8 (Map of Arkansas Geothermal Resources) and have the students locate Hot Springs and the Ouachita Mountains. Also distribute Student Worksheet 10.9 (From Core to Crust) and have the students complete.

b. Distribute Student Worksheet 10.10 (Geothermal Review) and have the students complete. Discuss with them. (the answer to each question is "geothermal")

4. Follow-Up Activities

Have the students go to the library and read as much as they can about geothermal energy.

TEACHER BACKGROUND INFORMATION

Sources:

Paul L. Butt. Arkansas and Energy. Arkansas Ecology Center: Little Rock. 1979.

Ray Sterling, Roger Aiken and John Carmody. Earth Sheltered Housing: Code, Zoning, and Financing Issues. United States Department of Housing and Urban Development: Washington, D.C. 1980.

A. J. Hand. Home Energy How-To. Harper and Row: New York. 1977.

Over the centuries, geothermal resources have been used in various places around the world for a variety of purposes, primarily recreational and therapeutic. Hot Springs, Arkansas, is one such place where heated waters flow naturally to the surface. Hot Springs, protected as a Federal Reservation since 1832, has long been one of the nation's leading spas. The waters of Hot Springs National Park have been and still are almost exclusively used for medicinal bathing. An exception is the water that is used to heat the Administration Building in the National Park. This is reflective of the growing realization and recognition that geothermal resources, such as the Hot Springs, have many potential uses. With expanded demand for energy and recent improvements in exploration and well drilling, geothermal resources are increasingly of interest for a broad range of uses. And Arkansas, beyond Hot Springs, has a geothermal potential and may participate in the development and utilization of this energy resource.

Geothermal energy is the product of heat radiated from the earth's interior which accumulates below the earth's surface in the form of hot rocks, hot water, or steam. This internal energy of the earth is thought to be the result of the natural decay of radioactive materials. The heat energy may remain trapped in hot rocks or be transferred to underground water and form hot water or steam. Natural crevices, such as hot springs or geysers, or drilled geothermal wells can bring this hot water or steam to the surface, where it can become a source of energy in selected local areas.

Another aspect of geothermal you may want to share with the students is the fact that one inch below the surface the earth's temperature is virtually constant. A home built underground can take advantage of this fact to cut heat losses. Appropriately used, the earth we build our subterranean homes in can be an effective passive design tool. Placed between a building and the outside elements, earth slows the heat transfer from one to the other; reduces the temperature difference between exterior and interior; and at the same time it protects the building from cold winds and the direct rays of the sun. However insulation is essential to reduce heat transfer as well as to prevent condensation on surfaces in contact with the earth.

Underground buildings are among history's oldest building forms and are re-emerging as serious alternatives to more traditional kinds of shelter. They first gained attention as a means of preserving land surfaces for other uses like agriculture in rural areas and as open spaces in urban areas. Some of the advantages to below-grade building is that is is dirt cheap, permanent, will not rot or rust, fireproof and will not fade, chip or peel. As with other building designs there are disadvantages to subterranean homes. These are associated with the dampness, insects and vermin, difficulty of cleaning, and lack of view.

GEOTHERMAL ENERGY READING SHEET

WHAT DO HOT ROCKS, HOT WATER, AND STEAM IN THE AIR MEAN?

DO YOU KNOW THAT THE INSIDE OF THE EARTH IS FILLED WITH HEAT?

DO YOU ALSO KNOW THAT AROUND THE HEAT ARE LAYERS OF ROCK AND SOMETIMES WATER?

DO YOU KNOW THAT THERE IS A THIN LAYER OF "DIRT" OVER ALL THIS?

DO YOU KNOW THAT THE HOT ROCK HEATS THE WATER ABOVE IT? AND THAT WHEN THE WATER GETS REALLY HOT IT FINDS AN OPENING IN THE GROUND AND COMES OUT? (think about a tea kettle on the stove; what happens to the water in the tea kettle when it gets really hot?)

An example is "Old Faithful" in Yellowstone National Park. It has been a popular tourist attraction for many years. Every 60 minutes, on the average, it erupts -- shoots steam as much as 200 feet into the air.

CAN YOU USE THESE THINGS TO MAKE HEAT AND LIGHT?
Yes, we can find steam coming out of the ground and pipe it to our homes to heat them or make electricity.

And if we cannot find steam, we can find hot water underground. Remember the interior of the earth has already heated it for us and all we have to do is pump it up and, presto, steam.

Or perhaps we can find hot rocks (and remember, hot rock is everywhere underground). If we find hot rock we pipe water down to it, get the water hot, and bring it up as steam to make heat and light.

"Old Faithful", the most famous of all geysers, is a symbol of one source of new power for the nation and possibly for Arkansas: geothermal energy.

ACCOUNTS OF GEOTHERMAL USES

Directions: Separate each of the eight accounts by cutting and then distribute each account to a group of students. Let them locate the place on the world map and then report to the rest of the class how geothermal energy is being used in the area marked.

1. Historically, the commercial use of geothermal energy for generating electricity dates back to 1904 in Lardello, Italy. This first use was to light five light bulbs. This is the world's first geothermal power plant and Italy still leads the world in producing geothermal electricity.

2. In the 1930's hot water, as hot as 265 degrees F or 130 degrees C, was used for heating municipal buildings in Reykjavik, Iceland.

3. The Geysers, California, is the first and only geothermal power project in the United States. It is about 90 miles north of San Francisco. The Geysers were frightening to William B. Elliott in 1845 when he discovered them while hunting a grizzly bear.

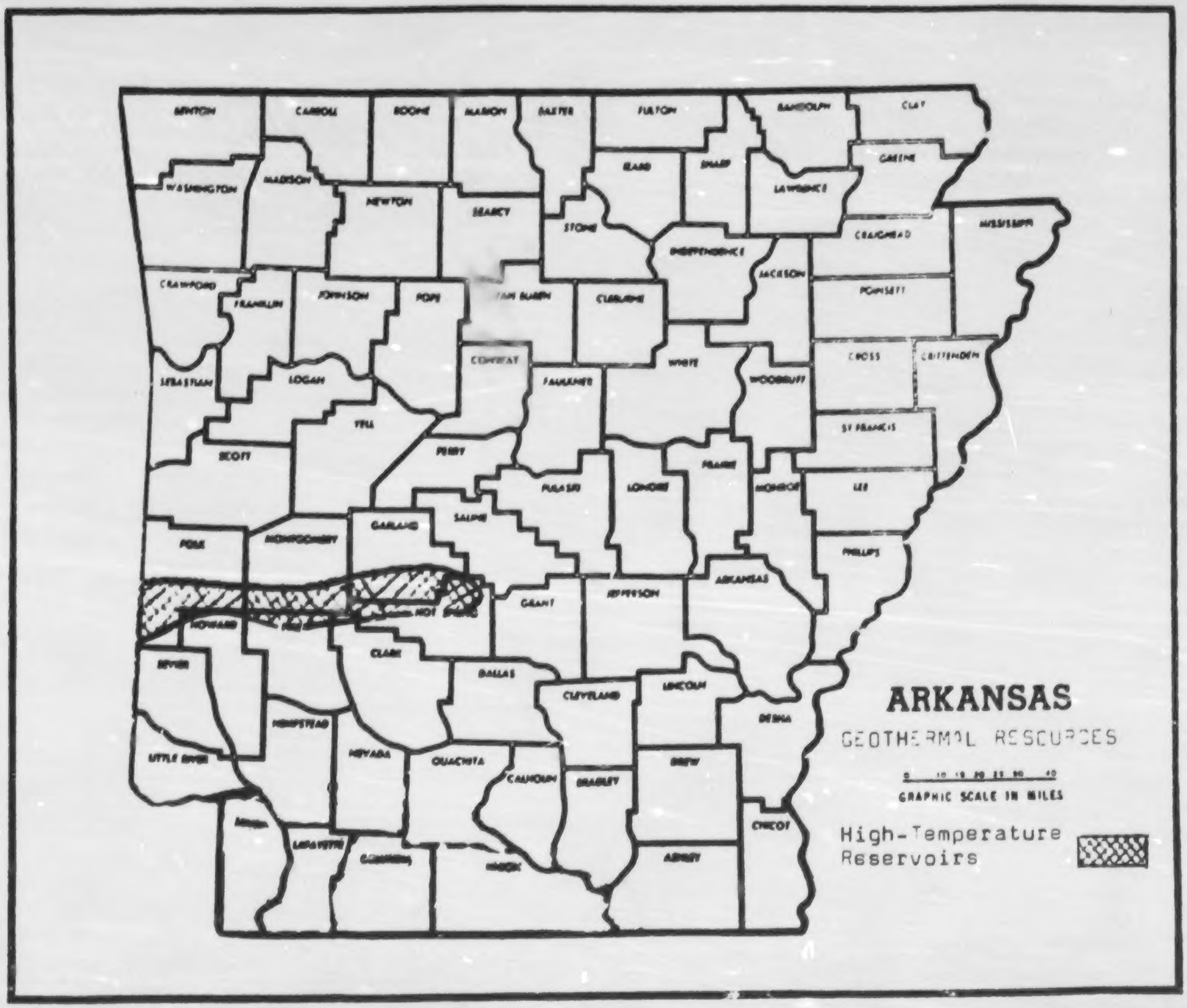
4. South of the United States border at Mexico's Cerro Prieto is a power plant that is tapping hot water under pressure. The water at this location is 570 degrees F. Can you tell the others in the class how this hot water at Cerro Prieto can make electricity?

5. There are more than 500 geothermal wells at Rotorua, New Zealand, (a city about the size of Pine Bluff with 38,000 people) that provide hot water for heating. There is one hotel that runs its air-conditioning system with geothermal water.

6. Boise, Idaho, and Klamath Falls, Oregon, have been heating homes with geothermal hot water wells for many years.

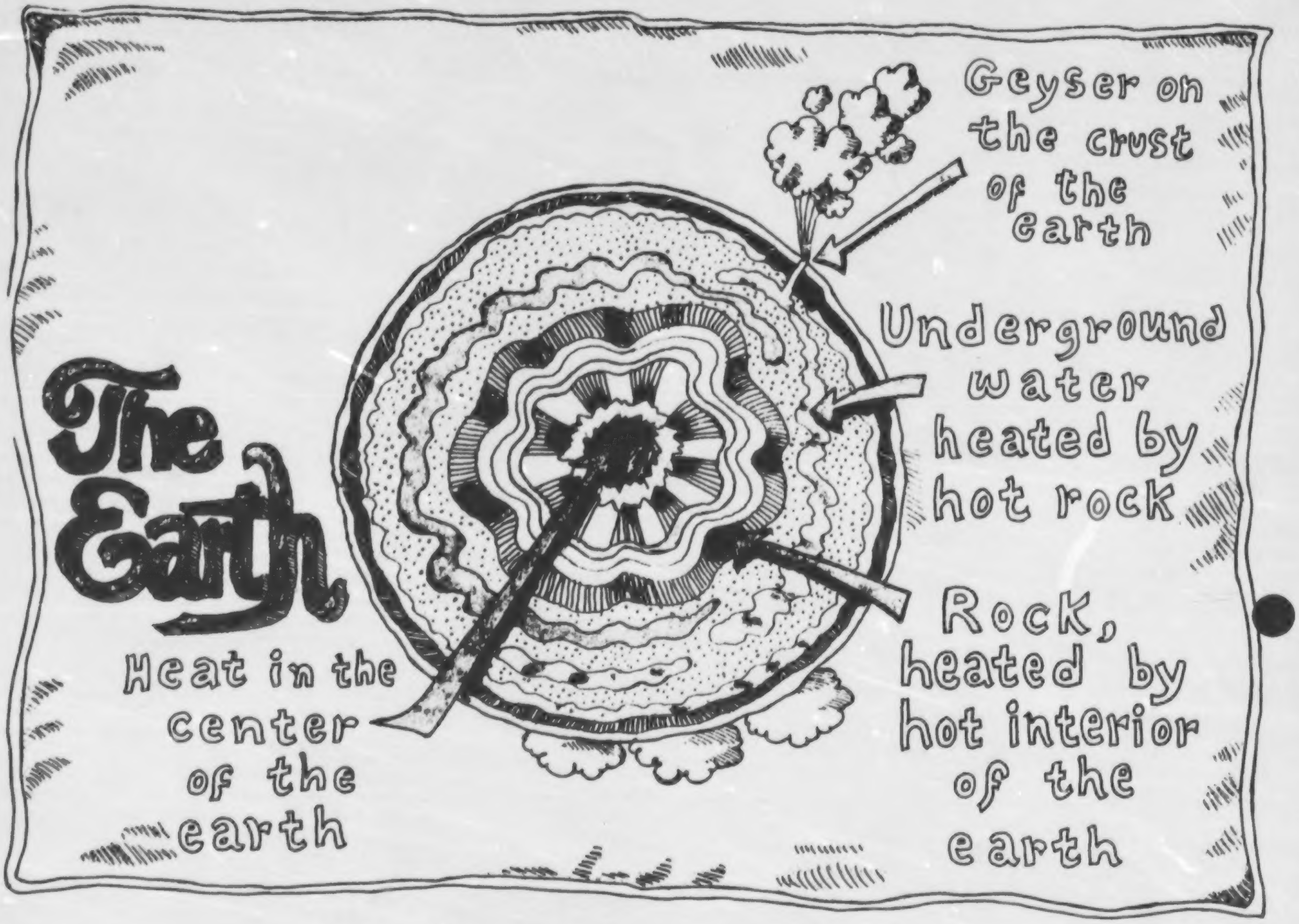
7. In Japan, geothermal deposits remain a largely untapped source of electricity, but the Japanese have experimented with soil heating and fish-farming projects using geothermal energy.

8. There are geothermal waters being tapped for recreational and therapeutic (helping to make well) uses in Arkansas. Can you tell the class why Hot Springs, Arkansas, is called the Spa City?


ARKANSAS
GEOTHERMAL RESOURCES
0 10 15 20 25 30 40
GRAPHIC SCALE IN MILES
High-Temperature Reservoirs ▨
BENTON
CARROLL
BOONE
MARION
BAXTER
FULTON
RANDOLPH
CLAY
WASHINGTON
MADISON
NEWTON
SEARCY
IZARD
SHARP
LAWRENCE
GREENE
STONE
INDEPENDENCE
CRAIGHEAD
MISSISSIPPI
JACKSON
CRAWFORD
FRANKLIN
JOHNSON
POPE
VAN BUREN
CLEBURNE
POINSETT
CONWAY
FAULKNER
WHITE
WOODRUFF
CROSS
CRITTENDEN
SEBASTIAN
LOGAN
YELL
PERRY
ST FRANCIS
SCOTT
PULASKI
LONOKE
PRAIRIE
MONROE
LEE
POLK
MONTGOMERY
GARLAND
SALINE
PHILLIPS
ARKANSAS
GRANT
JEFFERSON
HOT SPRING
HOWARD
PIKE
CLARK
SEVIER
DALLAS
CLEVELAND
LINCOLN
HEMPSTEAD
DESHA
LITTLE RIVER
NEVADA
OUACHITA
CALHOUN
BRADLEY
DREW
MILLER
LAFAYETTE
COLUMBIA
UNION
CHICOT
ASHLEY

Student Worksheet

FROM CORE TO CRUST


The Earth
Geyser on the crust of the earth
Underground water heated by hot rock
Rock, heated by hot interior of the earth
Heat in the center of the earth

1. What do you think this picture is about? Explain it.

2. What is geothermal energy?

3. What are at least two uses for geothermal energy?

LESSON #11

CATEGORY: Uses

ENERGY TYPE: All

TITLE: Shortage and Surplus

GRADE LEVEL: 4-6

TIME NEEDED: Two periods

INFUSE WITH SUBJECT AREA:

Social Studies
Economics

MATERIALS:

World wall map
Marbles (30 red, 25 green, 50 white, 30 black, 30 blue, 25 orange)

OBJECTIVE:

The students will learn about supply and demand and the relationship these have to energy cost in Arkansas.

TASK ANALYSIS:

The students should be aware of energy sources and be able to cooperate in small group learning activities.

PROCEDURE:

1. Preparation

   Duplicate Student Worksheets 11.4, 11.5, and 11.6.
   Gather above listed materials.

2. Steps in Lesson

   Objective: The students will learn about supply and demand and the relationship these have to energy cost in Arkansas.

   a. Introduce vocabulary

      - Demand - the amount of a good or service that buyers in a market are willing to buy at a specified price at a given time
      - Export - to send produced materials (goods) out of one nation for sale in another
      - Import - to bring in goods made in another nation
      - Shortage - less than the amount needed or wanted

- Supply - the amount of a good or service that is for sale

- Surplus - the amount of a good or service that is more than what is needed

b. Distribute Student Worksheet 11.4 (Supply and Demand) and have the students study and fill in the blanks. Encourage them to discuss ways in which shortages may cause the price of items in their own shopping experiences to increase.

- What has happened to the cost of comic books, the fee to go to the movie, the price of a candy bar, and the cost of all toys? Are these connected to an energy shortage?

- What happens if a local merchant has a surplus? (reduces prices)

c. Ask the students what effects a gasoline shortage would have on rural Arkansas. (cut back on automobile travel; might not be able to get to work, school or doctor; reduced amount of fuel for farm machinery; unable to take produce or cattle to market, etc.)

d. Discuss with the students the effect a gasoline shortage would have on the trucking industry. (no food deliveries, no building materials to contractors, no clothing to department stores, etc.) Will the price of other items go up? (yes)

e. Ask the students what would they do if their parents could not get any gasoline for their cars? (walk, bicycle, use public transportation, form car or van pools, move closer to jobs or schools)

f. Distribute Student Worksheets 11.5 and 11.6 (Energy Supply and Energy Demand in World Regions) and have the students discuss and complete. Discuss some of the above questions again now that they have seen the world map and know that the United States imports a lot of its needed energy.

3. Evaluation

a. Conduct the following game activity with the class to illustrate the fact that recurring shortages are occurring. Stress that the product's value is determined by its availability and the demand for that product.

- Mark off an area approximately 10 feet by 20 feet on a grassy surface outside the school building

- Scatter 150 colored marbles (25 of each color) in the grass

- Ask a team of students to recover as many marbles as possible within a set time limit. (Because of their color and the color of the grass, fewer green or tan objects should be found. Fewer green objects will be found in the summer months and fewer tan objects will be found in the fall or winter months.)

- Start the game again, changing the color distribution of the marbles to: 50 white, 30 red, 30 black, 30 blue, 10 green. Repeat the exercise.

- Which color proved easiest to find in terms of the number recovered? Why?

- Which color proved most difficult to find? Why?

- What products (minerals for example) can you think of that are high in price because they are in short supply?

- What raw materials are high in price because they are wanted by so many people for so many things?

b. Ask students to list alternatives to writing paper that is in limited supply for the rest of the school year. What could be used? (parts of unused paper, back side of paper, old pieces of construction paper, small reusable slates, etc.) Discuss with the students that scarcity of an item necessitates considering alternatives.

4. Follow-Up Activities

Have the students research fossil fuels and the amount of each and speculate on the market supply and demand for the next ten years in the United States; then speculate on the supply for the next twenty years; and then the next thirty years?

** Additional background information to help the teacher in discussion of 2b: The following is an excerpt from a speech given by Helen Holmes to the Women in Energy organization.

> In the United States the market is not sensitive to the increasingly high price of gasoline. Demand for petroleum is inelastic. When a product is elastic, the consumers respond to a small price increase by reducing their purchases substantially. When the consumer behaves in this way, there is a substitute product available and there is a competition among sellers. In addition, the product is usually not a necessity. For example, when butter cost 70 cents a pound many people will buy it; at $1.00 a pound far fewer people buy it and at $2.00 a pound most people will give up butter for margarine. As margarine goes up in price fewer people will buy it and some do without both butter and margarine. So if we can substitute for a product, or do without it, it is said that the market is elastic, i.e., the public is sensitive to price changes. Obviously this is not the way we have reacted to gasoline prices.
>
> Petroleum products are inelastic. We cannot substitute for them nor can we do without them. Price has not affected the quantity used. We haven't bought less at least not yet, and we don't know at what price the amount bought would be less. When and if that price is reached, the revenues for the oil companies will be multiplied immensely. So we see that people have not changed in their basic use of energy. Price may have forced some reduction in sales, i.e., conservation, but only by those who cannot afford it.

Student Worksheet

SUPPLY AND DEMAND: SHORTAGE AND SURPLUS

Finish the story by filling in the blanks. Think of the right answer. Then see if it appears in the answers below. Some answers may be used more than once.

POSSIBLE ANSWERS

40
lowered
supply
200 gallons
$10.00
5 gallons

shortage
raised
surplus
160 gallons
demand
$200.00

Mr. Smith, a gasoline station owner, received 200 gallons of gasoline regularly each week. His 20 regular customers were used to buying all the gas they needed. Although some weeks some people bought more and some bought less, average use was 10 gallons a week. The total demand for gasoline each week, then, was 1. ____________. As you have seen, Mr. Smith's supply was 2. _______. Everybody was happy about the whole thing. The supply was equal to the 3. __________.

Mr. Smith charged $1.00 a gallon for gasoline, a price that was about the same as that charged by the other station in town. Each regular customer spent an average of 4. ______________ each week. Mr. Smith received 5. __________ for gasoline. When the other station reduced its price per gallon by a penny, four of Mr. Smith's regular customers deserted him and went across the street. He was still getting a delivery of 200 gallons a week, but now the demand was only 6. ______________. He had 7. __________ gallons left over. This unbought quantity of gasoline is called a 8. ____________________. To get rid of the surplus, Mr. Smith 9. _________his price. His other regular customers bought up the 10. _____and took a few more pleasure trips into the city.

Several weeks later, Mr. Smith and the other station each received only 100 gallon of gasoline. Their suppliers were short of gasoline that week. Their customers' demands were still the same, so the pumps soon became empty. "No More Gas!" the sign in front said. Halfway through the week, Mr. Smith had a 11. __________ of gasoline. By still charging $1.00 a gallon, he didn't make enough to pay the costs of his station.

The next week he raised the price to $2.00 a gallon. Even at the higher price, most of his customers still had to buy gas to drive to work and do errands, so he sold all 100 gallons. How much money did he receive? 12. __________. What was the average amount each of the 20 regular customers spent? 13. _____________. What was the average amount of gas each customer used? 14. ________

Some of Mr. Smith's customers were on a fixed budget and couldn't afford to spend more than $3 a week for gas. Some customers got to the station after the pumps were empty and couldn't get all they needed. Some of the other station's customers came over to Mr. Smith's station. The demand was greater than the 15. ________. Mr. Smith 16. __________ his gasoline prices again.

Discuss in your class ways in which the people of Smalltown might solve their gasoline supply problem.

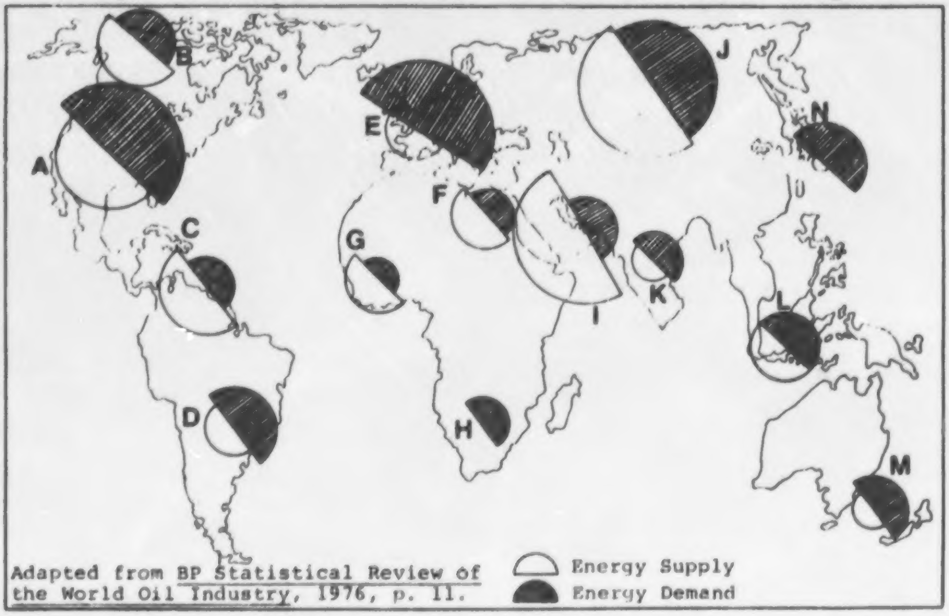
Source: United States Department of Energy

Supply & Demand:
Shortage and Surplus
Answer Sheet

1. 200 gallons
2. 200 gallons
3. demand
4. $10.00
5. $200.00
6. 160 gallons
7. 40
8. surplus
9. lowered
10. surplus
11. shortage
12. $200.00
13. $10.00
14. 5 gallons
15. supply
16. raised

Student Worksheet

Energy Supply and Energy Demand in World Regions



Adapted from BP Statistical Review of the World Oil Industry, 1976, p. 11.

○ Energy Supply
● Energy Demand

Place a check in the appropriate column. Base your choice on the information on the map. The first one has been done for you.

Code	Area or Nation	Supply Greater than Demand	Demand Greater than Supply	Balance Supply & Demand
A.	United States		x	
B.	Canada			
C.	Caribbean			
D.	South America			
E.	Western Europe			
F.	North Africa			
G.	West Africa			
H.	South Africa			
I.	Middle East			
J.	USSR			
K.	South Asia			
L.	Southeast Asia			
M.	Australia			
N.	Japan			

Source: National Science Teachers Association

STUDENT WORKSHEET
ANSWER SHEET

Energy Supply and Energy Demand in World Regions

Supply Greater

B. Canada
C. Caribbean
F. North Africa
G. West Africa
I. Middle East
J. USSR

Demand Greater

A. United States
D. South America
E. Western Europe
H. South Africa
K. South Asia
M. Australia
N. Japan

Balance

L. Southeast Asia

ENERGY SUPPLY AND ENERGY DEMAND

Questions

You will need to look carefully at the map in order to answer the following:

1. Which regions probably have to buy oil from foreign nations?

   A.
   B.
   C.
   D.
   E.
   F.
   G.

2. Trade partners are those who have something to sell and those who need to buy. Can you find several possible trade partners? List them. Partners can be mentioned more than once.

   A.
   B.
   C.
   D.

3. In addition to the need for oil and the supply of oil, what other factors will influence what nations will be trade partners?

STUDENT WORKSHEET
ANSWER SHEET

Energy Supply and Energy Demand

1. United States
   South America
   Western Europe
   South Africa
   South Asia
   Australia
   Japan

2.

Middle East	Western Europe
Canada	United States
Caribbean	South America
Caribbean	United States

3. Economic considerations such as the ability to pay for the oil and political considerations such as alliances.

LESSON #12

CATEGORY: Sources

TITLE: Clean and Renewable:
A Super Ordinary Star

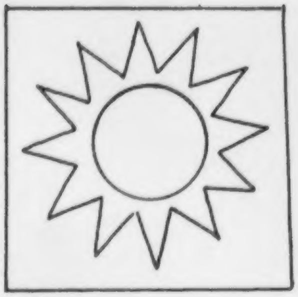
INFUSE WITH SUBJECT AREA:

Science
Social Studies
Language Arts

ENERGY TYPE: Direct Solar

GRADE LEVEL: 4-6

TIME NEEDED: One period



MATERIALS:

- 6-cm magnifying glasses (5)
- Chairs or stools (5)
- Masking tape
- Watch with second hand
- White paper
- Camera's flash reflector
- Wooden match

OBJECTIVE:

The students will recognize that the sun, for all practical purposes, is an inexhaustible and clean energy source ready for use in Arkansas.

TASK ANALYSIS:

The students should be able to follow written directions and work in groups.

PROCEDURE:

1. Preparation

   Read Teacher Background Information (12.4).
   Duplicate Student Worksheets 12.5, 12.6, 12.7, 12.8.
   Gather above-listed materials.

2. Steps in Lesson

   Objective: The students will recognize that the sun, for all practical purposes, is an inexhaustible and clean energy source ready for use in Arkansas.

   a. Ask the students if there is a star they can see in the daytime. What is round, hot with a surface temperature of 6,000 degrees C. or about 10,000 degrees F., yellow, a star, and 93 million miles away. (sun) Have the students list ways the sun helps them. (warmth, light, energy) Then ask the students what energy source is everywhere on earth, has been present for 5 billion years and will last 5 billion more, and is the force behind the rivers, winds, and seasons. (sun)

b. Distribute Student Worksheet 12.5 (Let's Power Spaceship Earth with the Sun). Divide the class into groups of four or five students. Let the students within the groups read to each other, discuss the answers, and complete the worksheet.

c. Demonstrate the concentration of sunlight on a piece of paper. Be sure to caution the students about the danger of starting a fire and/or burning their skin. Take a magnifying glass outside and hold it in the sunlight so the smallest possible image of the sun is produced on the piece of paper. Keep the glass steady and after a short time the paper will smolder. Tell the students that this is true whether the air temperature is zero or ninety.

   Demonstrate a second way that sunlight can be concentrated. Take a camera's flash reflector and hold it so that sunlight falls directly on the shiny face. With your other hand push a wooden match through the bulb opening so the head of the match extends into the reflector. If the match is in the same position that the filament of the bulb would occupy the match will ignite.

d. Ask the students to guess how long a magnifying glass would focus in the same spot at a certain time of the day. Have the students work in groups of four or five and do Student Worksheet 12.6 (Sun on the Move). Allow plenty of time for the students to repeat the investigation at two other times, say 10:00 a.m. and 3:00 p.m. Develop with the students the concept of the earth changing its place in space. The earth rotates on its axis once every twenty-four hours. It also revolves in an orbit around the sun along with other planets. The group of stars to which the sun belongs is also moving through space.

e. Ask the students if they can think of any complications this movement of the sun would have if their parents were planning to collect solar energy for use at home. (Collectors must have an adjusted tilt to take advantage of the direct sun's rays.)

f. Review with the students why the sun is called the source of all energy except nuclear and geothermal. (Our food production and all life-support systems of the natural environment are dependent on the sun.) (The fossil fuels have energy because the energy was trapped from the sun by the plants and animals the fossil fuels used to be.)

3. Evaluation

a. Ask the students what they would think about sun bathing in January in Arkansas. How would a reflector help? (Sheets of aluminum foil concentrate sunlight so that one can bathe outside in comfort and get a deep tan even at very low temperatures.

b. Distribute Student Worksheet 12.7 (Find the Hidden Message) and have the students unscramble the words and find the hidden message.

c. Distribute Student Worksheet 12.8 (A Super Ordinary Star). Have the students cut out the pieces and put them together.

4. Follow-Up Activities

Have the students research the legend about Archimedes using solar reflecting mirrors to set fire to a Roman fleet besieging Syracuse in 212 B.C. (In 212 B.C. Archimedes turned the sun's energy into a weapon. He commanded 4,000 Greek soldiers to focus their gold and bronze shields upon the wooden ships of an attacking Roman fleet. Reportedly the sails were black and easily caught fire, burning the vessels to the waterline.)

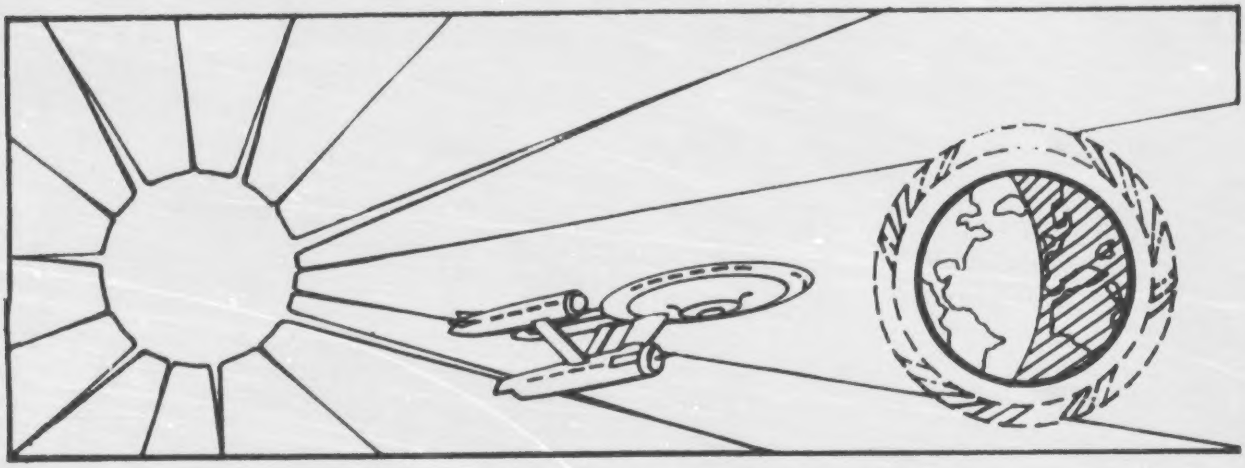
TEACHER BACKGROUND INFORMATION

The sun is so familiar to us that perhaps we take it for granted and do not know of its super presence.

The sun, a hot ball of gas, is a huge sphere, so large that 845,000 earths could be poured into it and still have room to rattle around. And yet it is rather ordinary in comparison with other stars. However, the sun is above average in brightness, mass, and size and it is the center of our solar system. The earth and eight other planets revolve around the sun as it radiates energy in all directions (called electromagnetic energy). As it travels through space most of the energy moves as infrared waves, visible light, and ultraviolet waves.

The sun is a super ordinary star for all plants and animals on earth. If we had no sun there would be no life.

Student Worksheet



LET'S POWER SPACESHIP EARTH WITH THE SUN

The sun, 93 million miles away from earth, sends more radiant energy toward us every second than people have used in the course of human history. Thirty per cent of this energy is reflected back into space by our atmosphere. Much of the remaining radiant energy of the sun heats the land and the water; it evaporates water and melts the snows. It is the source of energy that creates the winds and great ocean currents, and it warms the atmosphere that surrounds us.

Solar energy reacts with plants in the chemical process of photosynthesis to provide the stored energy that fuels life. Coal and oil and natural gas, once swamp jungles of the ancient earth, are stored solar energy. All of these are ways we benefit from the sun's energy directly.

We also benefit indirectly from the sun's energy when that energy comes to us "secondhand". The electricity generated by a windmill, for example, is the sun's energy once removed. So, too, is the energy our bodies get from the food we eat.

Less than one per cent of the incoming solar energy is used to sustain plant and animal life, yet this amount is many times greater than the total electric generating capacity of the entire world. The sun is an important part of the answer to our energy dilemma.

Humans from the dawn of history have put the energy from the sun to work to keep warm or to grow food, or by harnessing the wind. In what ways did early people use the sun to do work for them?

What has the energy from the sun made possible in your life today?

Put a D beside each of the following that result from energy received directly from the sun. Put an I beside each that results indirectly from the sun's energy.

1.______coal deposits
2.______sailboats
3.______forests
4.______gasoline
5.______photosynthesis
6.______Arkansas streams
7.______windmills
8.______rice fields
9.______candy bar
10.______electric heater
11.______leaves turning green
12.______Arkansas lakes
13.______steam engine
14.______natural gas deposits

Source: United States Department of Energy

Student Worksheet

LET'S POWER SPACESHIP EARTH WITH THE SUN
(answer sheet)

1. D
2. I
3. D
4. I
5. D
6. I
7. I
8. D
9. I
10. I
11. D
12. I
13. I
14. D

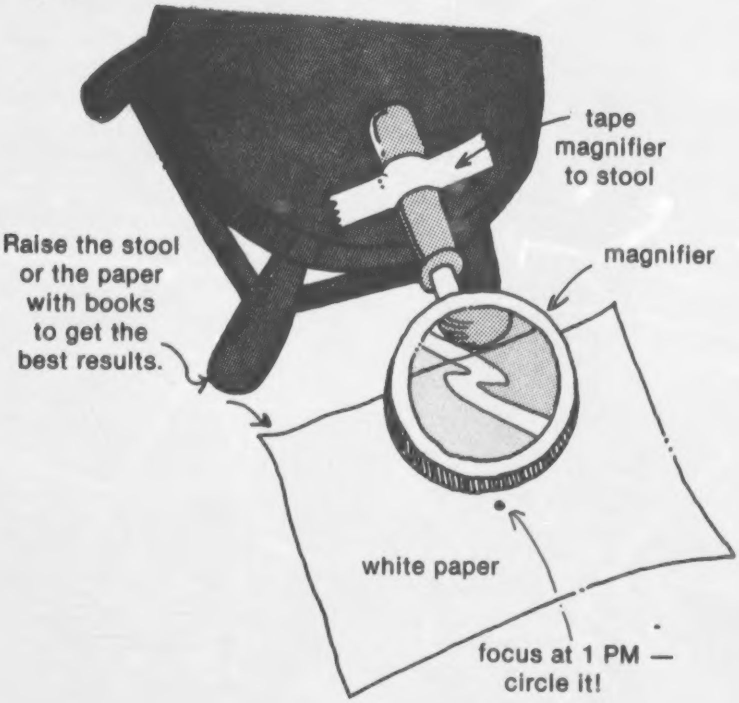
Student Worksheet

SUN ON THE MOVE

1. How long do you think a magnifying glass will focus in the same spot at one o'clock? __________

2. You and the others in your group will need a magnifying glass, chair or stool, masking tape, watch with a second hand, and some white paper.

3. Look at the diagram to right and assemble yours the same way.


tape magnifier to stool
magnifier
Raise the stool or the paper with books to get the best results.
white paper
focus at 1 PM — circle it!

4. Adjust the lens to the best focus on a piece of white paper. What direction is that? ______________ What shape is the light on the white paper? __________

5. Mark the position of the light by circling it. Measure the time it takes for the light to leave the entire circle. How long did it take?

6. Will it take longer for the spot of light to move from the circle at 10:00 a.m.? ______ If so, why? If not, why not? _______________________

7. Does the spot move faster, slower, or the same at three o'clock as it did at one o'clock? __________ Why? _________________________________

Student Worksheet

SUN ON THE MOVE
(answer sheet)

1. answer will vary

4. south; round

5. answer will vary

6. answer will vary

7. faster

(It will take an average of fifteen minutes for the spot to move in this investigation. The exact time will depend on the position of the sun.)

Student Worksheet

FIND THE HIDDEN MESSAGE

Directions: Unscramble the letters on the left to form words that were used in Let's Power Spaceship Earth With The Sun. Write the word in the blanks on the right and then take the blocked letters and write at the bottom of the page to find the hidden message.

1. N I D $\boxed{A}$ T A R - - - - - - -
2. L I M L D $\boxed{W}$ I N - - - - - - - -
3. R T G $\boxed{A}$ N E E E - - - - - - - -
4. L F $\boxed{R}$ E T C E - - - - - - -
5. S H R A T $\boxed{E}$ E O M P - - - - - - - - - -
6. G E R $\boxed{N}$ E Y - - - - - -
7. I C $\boxed{E}$ L T C Y E R T I - - - - - - - - - - -
8. I $\boxed{S}$ O N T E S P O H T Y S - - - - - - - - - - - - - -
9. V O R E A T A $\boxed{S}$ E P - - - - - - - - - -

SOLAR - - - - - - - - -

Information to think about: The word aware comes from an old English root meaning to be watchful, or on the alert.

Solar Awareness means ______________________________

Student Worksheet

FIND THE HIDDEN MESSAGE
(answer sheet)

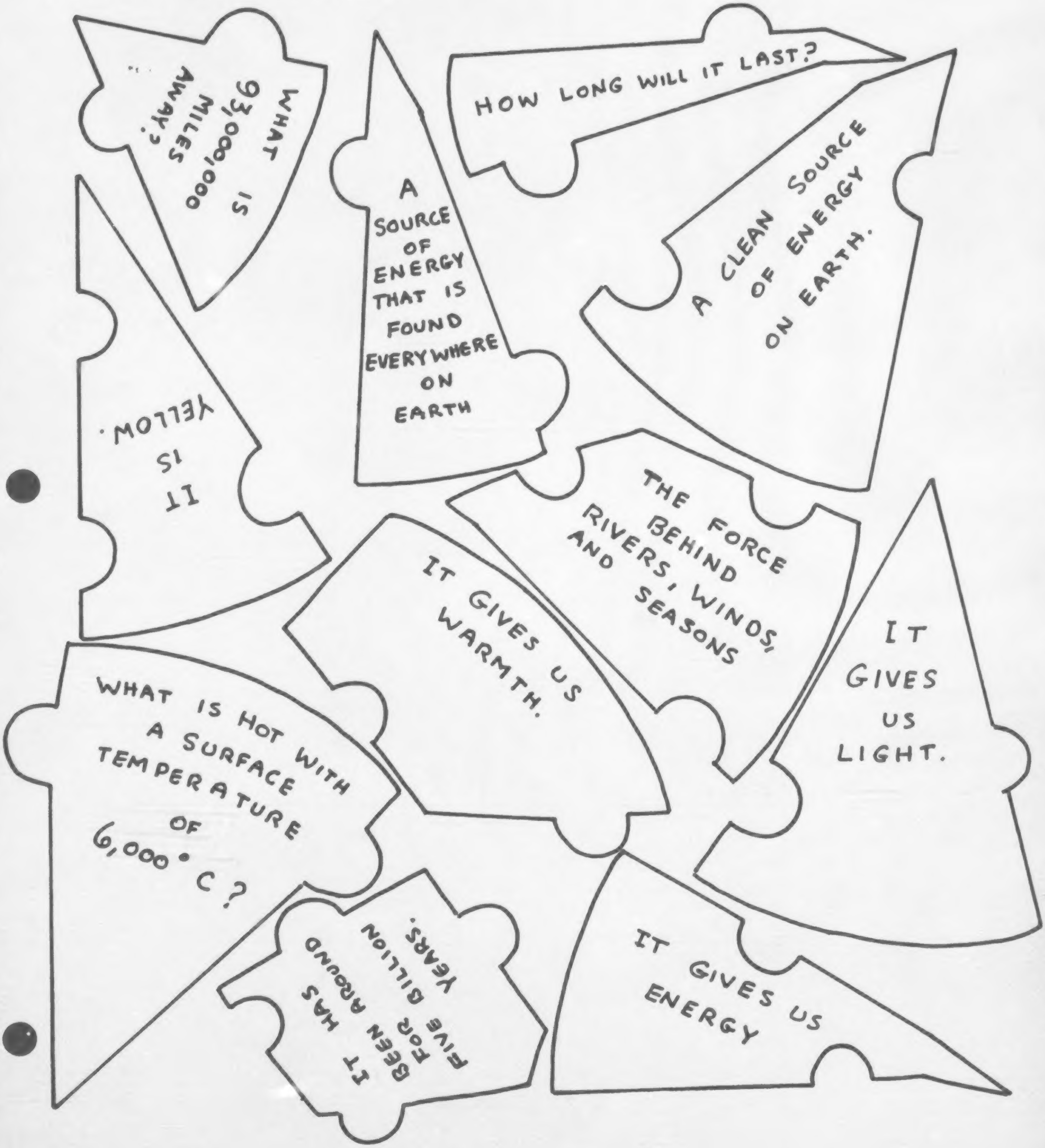
1. Radiant
2. Windmill
3. Generate
4. Reflect
5. Atmosphere
6. Energy
7. Electricity
8. Photosynthesis
9. Evaporates

Awareness

Student Worksheet

A SUPER ORDINARY STAR

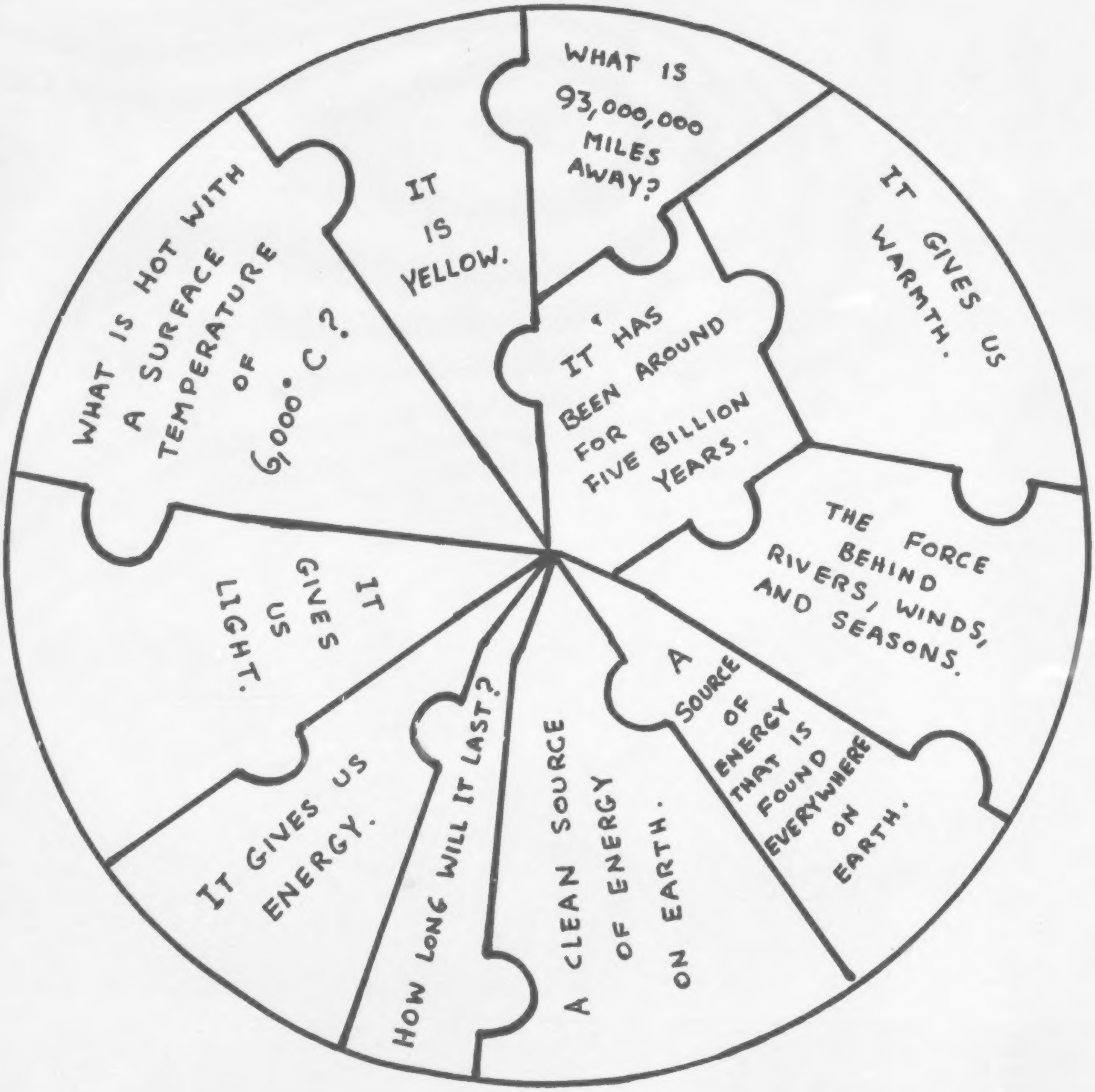
Directions: Cut out each piece below and put the puzzle together. Be sure and read what is on each piece.


WHAT IS 93,000,000 MILES AWAY?
A SOURCE OF ENERGY THAT IS FOUND EVERYWHERE ON EARTH
HOW LONG WILL IT LAST?
A CLEAN SOURCE OF ENERGY ON EARTH.
IT IS YELLOW.
THE FORCE BEHIND RIVERS, WINDS, AND SEASONS
IT GIVES US WARMTH.
IT GIVES US LIGHT.
WHAT IS HOT WITH A SURFACE TEMPERATURE OF 6,000° C?
IT HAS BEEN AROUND FOR FIVE BILLION YEARS.
IT GIVES US ENERGY

Student Worksheet

A SUPER ORDINARY STAR

(Answer Sheet)


WHAT IS 93,000,000 MILES AWAY?
IT GIVES US WARMTH.
IT HAS BEEN AROUND FOR FIVE BILLION YEARS.
THE FORCE BEHIND RIVERS, WINDS, AND SEASONS.
A SOURCE OF ENERGY THAT IS FOUND EVERYWHERE ON EARTH.
A CLEAN SOURCE OF ENERGY ON EARTH.
HOW LONG WILL IT LAST?
IT GIVES US ENERGY.
IT GIVES US LIGHT.
WHAT IS HOT WITH A SURFACE TEMPERATURE OF 6,000° C?
IT IS YELLOW.

LESSON #13

CATEGORY: Uses

ENERGY TYPE: Direct Solar

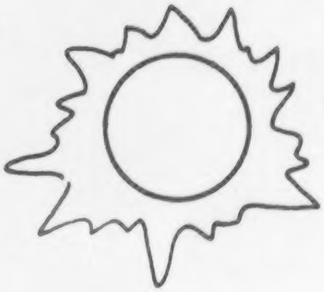
TITLE: Clean and Renewable:
A Solar Stroll

GRADE LEVEL: 4-6

TIME NEEDED: One period

INFUSE WITH SUBJECT AREA:

Science
Social Studies
Art



MATERIALS:

Thermometers (3)
Bedsheet (large)
Roll of newsprint
Crayons
Optional: Film: "The Solar Generation" (free loan)

OBJECTIVE:

The students will know that the energy from the sun must be captured to make solar devices functional.

TASK ANALYSIS:

The students should be perceptive of their surroundings, follow directions, be cooperative and work with other students.

PROCEDURE:

1. Preparation

   Duplicate Student Worksheet 13.3.
   Assemble materials.
   Cut a large bedsheet into four cloaks: two pieces should be dyed black.
   Optional: Order the film, "The Solar Generation", from United States Department of Energy, Technical Information Center, Box 62, Oak Ridge, Tennessee, 37830. Free loan.
   Optional: Contact Arkansas Energy Office, 3000 Kavanaugh, Little Rock, Arkansas, 72205. Films available include "Solar Promise" and "Solar Energy: How It Works." "How it Works" is narrated by students and is specifically designed to show how people can "do" solar themselves. Free loan.

2. Steps in Lesson

   Objective: The students will know that the energy from the sun must be captured to make solar devices functional.

   a. Tell students that all of them are going to take a "Solar Stroll". They will take turns wearing the black and white cloaks.

   b. Have the students notice the difference in temperatures between

      - The sidewalk and the ground

- The north side of the building and the south side of the building.

- The inside temperature of a parked car with all the windows up and the temperature of one with all the windows down

- A car with dark upholstery and one with light upholstery

c. Point out that green plants and leaves are collectors of sunlight. The rays from the sun are converted to food which is an important energy source. Ask the students, how does this process of photosynthesis produce fuel for our homes (firewood) and sometimes for our cars (alcohol).

d. Return to the classroom and discuss with the students why the dark cloaks got warm, the car with the dark upholstery had a higher temperature, etc. (The rays of sunshine have short wave lengths which can penetrate glass readily. But after the rays are absorbed by the dark objects, the light is converted to heat which has a long wave length that cannot go back through the glass easily. Consequently there is a heat build up.)

e. Optional:
View and discuss "The Solar Generation", a 15-minute film which briefly reviews the history of solar energy development, discusses the pros and cons of solar energy, and shows several solar devices in operation.

View and discuss "Solar Promise" and or "Solar Energy: How It Works."

3. Evaluation

a. Have the students write a letter to their parents telling how energy from the sun could be used at home for both heating and cooling. Start the letter with "Today I Took a Solar Stroll and . . ."

b. Distribute Student Worksheet 13.3 (Who Are You?) and have the students complete.

4. Follow-Up Activities

Make a sun portrait. Let each student select a partner. One student is to stand with his/her back to the sun with the newsprint in front of him/her. (Shadows are made when a person or object blocks out the light from the sun.) The partner traces the outline with a crayon. The students switch places and repeat the tracing on the newsprint. Then each one is to fill in his/her own features. Ask the students if their portrait is the same size as they are. Perhaps you will want them to repeat this at another time and compare sizes. (Shadows grow when the sun gets low.)

Student Worksheet

WHO ARE YOU?

Are you someone who . . .

Yes No Maybe 1. will insist on a black Little League uniform next summer?

Yes No Maybe 2. will wear your new white ski suit this Christmas?

Yes No Maybe 3. will insist on a white roof on your house in Arkansas?

Yes No Maybe 4. keeps darkening shades drawn on the windows in the summer to keep it cool?

Yes No Maybe 5. will park your car with all the windows up tightly?

Yes No Maybe 6. will want your bicycle to have a light color seat cover?

Yes No Maybe 7. tells others how to conserve energy?

Yes No Maybe 8. knows that photosynthesis can produce food for your family?

Yes No Maybe 9. will prefer dark clothes to wear when taking a winter hike?

Yes No Maybe 10. will walk barefooted on the hot sand along an Arkansas lake in August?

LESSON #14

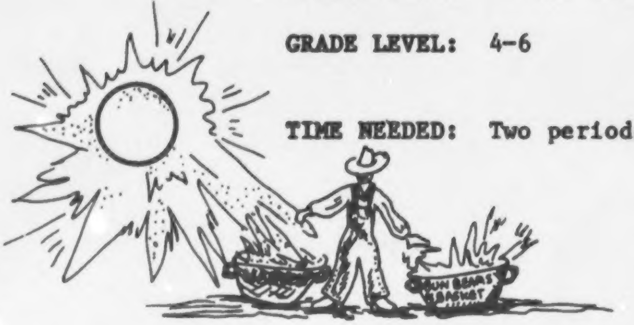
CATEGORY: Sources

TITLE: Clean and Renewable:
Harvesting Sunlight

ENERGY TYPE: Direct Solar

GRADE LEVEL: 4-6

TIME NEEDED: Two periods



INFUSE WITH SUBJECT AREA:

Science
Social Studies

MATERIALS:

1 roll clear plastic wrap
1 pint flat black paint
10 plastic or cardboard tubes (from roll of paper towels)
5 cardboard boxes, 60 to 100 cm long, 30 to 60 cm wide
1 white plastic trash bag
1 green plastic trash bag
1 black plastic trash bag
3 3x3 pieces of insulating material (styrofoam, cardboard, newspaper, etc.)
5 thermometers
Tape
Several sheets of construction paper (various colors)

OBJECTIVE:

The students will know that the energy from the sun can be used in meeting the daily needs of Arkansans.

TASK ANALYSIS:

The students should be able to follow written directions, work with others, investigate, and record results.

PROCEDURE:

1. Preparation

   Read Teacher Background Information (14.4).
   Duplicate Student Worksheets 14.5, 14.6, 14.7 and 14.8.
   Assemble above-listed materials.

2. Steps in Lesson

   Objective: The students will know that the energy from the sun can be used in meeting the daily needs of Arkansans.

   a. Make a solar device that will capture the sunlight. Distribute Student Worksheet 14.5 (My Own Flat Plate Collector) and have the students work in groups of five to construct the collector.

   b. Ask the students what is one way to get hot water if their electric or gas water heaters were not working and the repair person could not come. (sun) What is a solar water heater? Record their comments on how it would work and after they do the next investigation go back to this list and clarify any misconceptions.

c. Distribute Student Worksheet 14.6 (A Solar Water Heater) and discuss all the parts of the water flow system. (The basic function of a solar home hot water system is the collection and conversion of solar radiation into usable energy. Solar radiation is absorbed by a collector, placed in storage as required, with or without the use of a transfer medium, and distributed to point of use. In other words, the distribution component receives heat energy from the collector or storage, and dispenses it at points of use as hot water.)

d. Ask the students what would be the best color for the bottom of the solar water heater collector. After they have named some colors and the reason they think a particular color would be best divide the students into 3 groups. Distribute Student Worksheet 14.7 (The Collectable Color) and let one group investigate with the white plastic bag, one group with the green plastic bag, and the other group with the black plastic bag.

- Go outside, place the insulating materials on the ground and cover with aluminum foil.

- Fill each plastic bag with two liters of water, squeeze the air out of the bag and tie closed. Make a small hole in each bag and insert a thermometer. Tape tightly so that the bags do not leak.

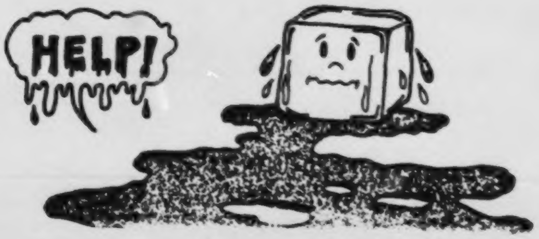
- Record the temperatures of the three collectors before they are placed on the aluminum foil in the sun. Place all three plastic bags on the aluminum foil in the sun. Record the temperatures again in 15 minutes.

- Discuss with students what causes the difference in temperatures recorded. (Just having the sun rays hit the plastic bags is not enough because some will bounce away - be reflected - and some will soak up most of the sun's rays. The sun rays will be absorbed more by the black bags.)

- Encourage the students to speculate how this could affect Arkansas homes and industries. Ask them to write a sentence or two explaining the value of having a light-color roof on their homes in Arkansas.

3. Evaluation

a. Ask the students to guess (predict) and then investigate what color would melt an ice cube the fastest. Have several different colors of construction paper ready for the students to select from. Let them get an ice cube and go outside. Place the ice cube on the construction paper in the sun and wait! Compare the results.



b. Distribute Student Worksheet 14.8 (Energy From The Sun) and have the students complete.

4. Follow-Up Activities

   a. Research why solar water heaters are big items on the market in Israel, Japan, and Australia. (Solar-rich countries, i.e., areas of abundant sunlight).

   b. Have a Solar Field Day. Let the students demonstrate their solar collectors to other classes or to their parents. Be sure to plan an alternate date in case the first choice is rainy or cloudy.

SOLAR COLLECTORS

Solar collectors are generally in the shape of a flat box, perhaps three feet on a side and a few inches thick. The back inside of a box is blackened and it is covered with a transparent sheet. When oriented toward the sun, usually by placing it on a south-facing roof, the blackened surface is heated by solar radiation. Circulating air or water through this box carries the absorbed heat to some storage device such as a tank of water. About 30 per cent to 50 per cent of the energy reaching the collector can be transferred to the fluid.

Dark colors absorb heat much better than light colors, but they also tend to reradiate the heat. This fact has a practical application when choosing a roof or house color. A black roof would absorb most of the sun's rays. A white roof would reflect most of the light that strikes it.

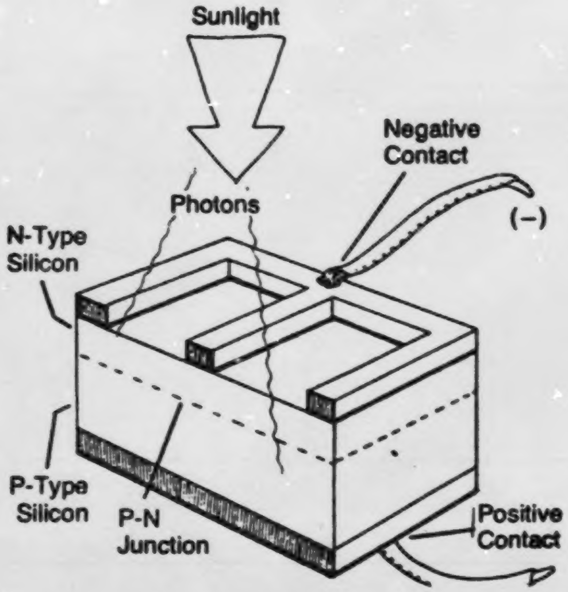
Another type of collector is called photovoltaics or solar cells. Perhaps you will want to share some general information with the students. Research indicates that photovoltaics appear to offer the best hope of containing the price of electricity, one of the most pervasive and convenient forms of energy.

Almost as if by magic, these semi-conductor-like devices convert sunlight directly into electricity. The sunlight energizes a cell which then releases a stream of charged particles. When subjected to an electric field the particles form a current that flows out along a circuit path. Photovoltaics is providing electricity for Mississippi County Community College in Blytheville, Arkansas.

There are some drawbacks to the implementatin of solar cells usage on a large scale. The efficiency, cost, and application of three different types of cells are being studied and evaluated.

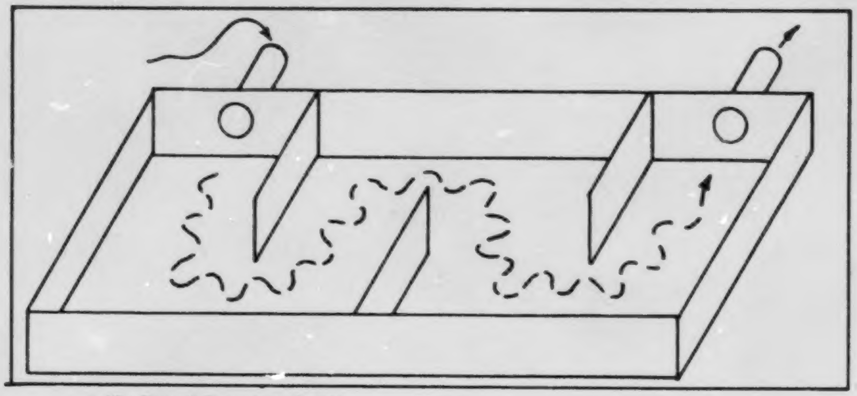
Silicon Solar Cell

Solar energy striking the P-N junction liberates electrons and causes a voltage difference between the contacts.



Student Worksheet

MY OWN FLAT PLATE COLLECTOR



A Flat Plate Collector (Air Type).

1. You will need a cardboard box; plastic or cardboard tubes; tape; flat black paint; clear plastic wrap; thermometers.

2. Cut the cardboard box down until it is only 10 to 15 cm deep. Cut holes in one side and insert the tubing. Place tape on the inside and outside of the box side to secure the tubes. Paint all the inside surface black.

3. Make as many baffles (half dividers) as possible. The more baffles the greater your chance is that the air will go over the entire collector.

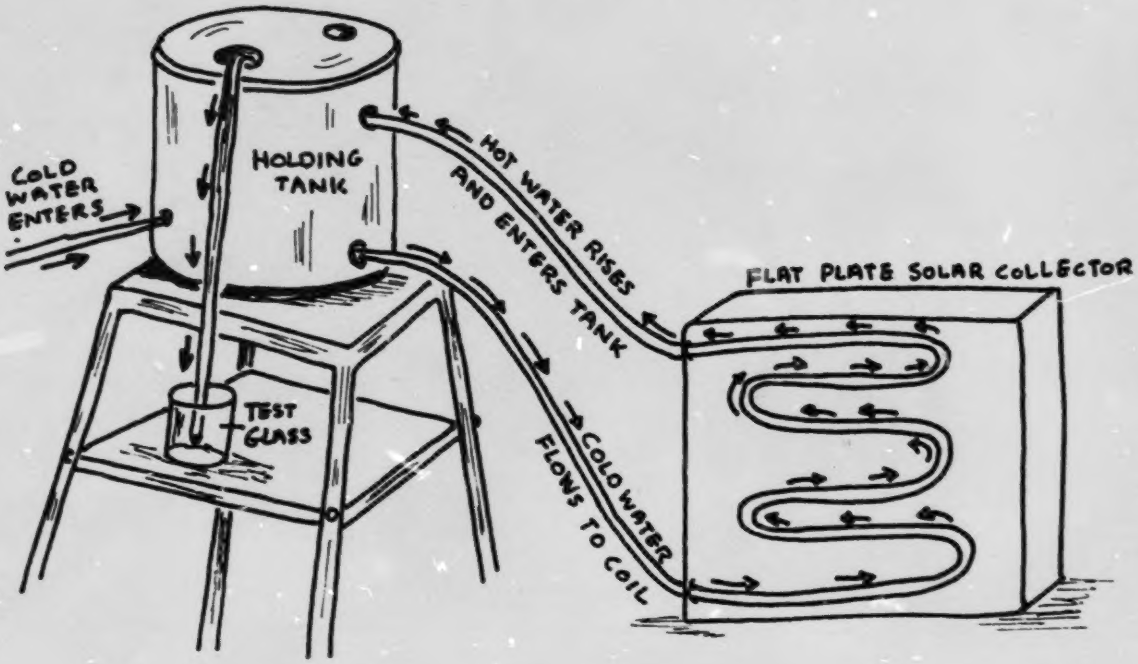
4. Cover the top with the clear plastic wrap. Seal with tape so it will be airtight.

5. Tilt the collector toward the sun. Insert thermometers in the tubes to measure the temperature increase.

Source: Joseph S. Cantrell and Jack Lee Mason. "Activities for Teaching Solar Energy". Science and Children. April, 1980. p. 17.

Student Worksheet

A SOLAR WATER HEATER



The cold water enters the holding tank from the left, fills the tank, and flows to the coil of the flat plate collector. This solar water heater is not useful unless the holding tank is above the coil. As the coil heats water inside it, the water rises and is replaced by cooler water drawn from the bottom of the tank. If you did not have the test glass and the opening in the top of the tank was plugged, how could you tell if the water was getting warm or circulating? ____

____

____

____

Student Worksheet

A SOLAR WATER HEATER
ANSWER SHEET

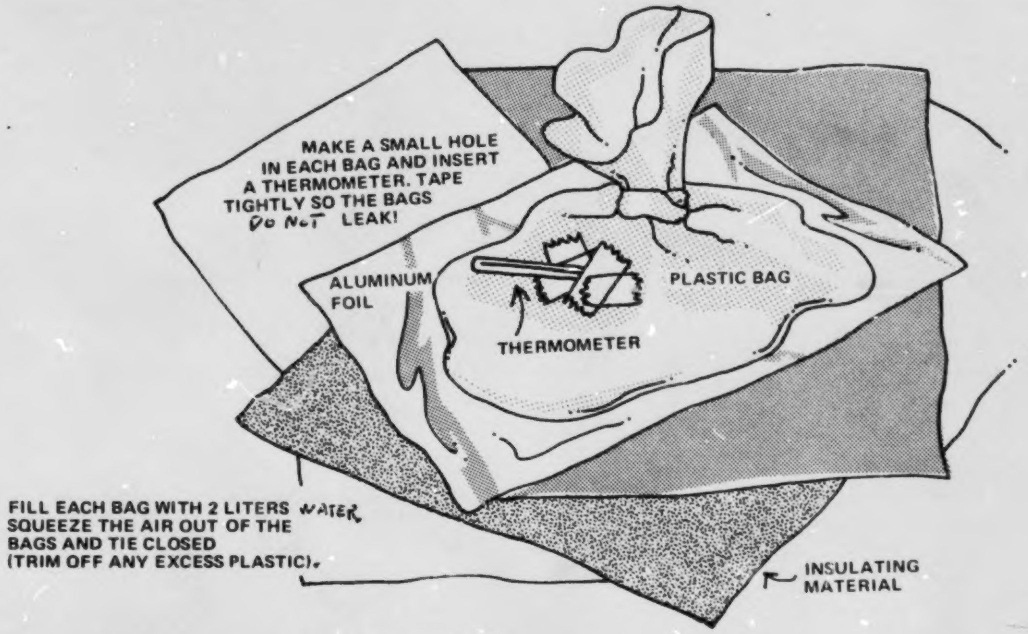
Place your hands on both hoses; the top one will be warmer than the lower one.

Student Worksheet

THE COLLECTABLE COLOR

1. Your group will need either a white, green or black plastic trash bag; some insulating materials such as cardboard, newspaper, styroform, etc.; aluminum foil; a thermometer; and a roll of tape.

2. Go outside the classroom and put the insulating material covered with aluminum foil in the sun.


MAKE A SMALL HOLE IN EACH BAG AND INSERT A THERMOMETER. TAPE TIGHTLY SO THE BAGS DO NOT LEAK!

FILL EACH BAG WITH 2 LITERS WATER
SQUEEZE THE AIR OUT OF THE BAGS AND TIE CLOSED (TRIM OFF ANY EXCESS PLASTIC).

3. Record the temperatures of all three collectors and then place yours beside the other two on the insulation. Record the temperatures again in 15 minutes.

4. What causes the difference?

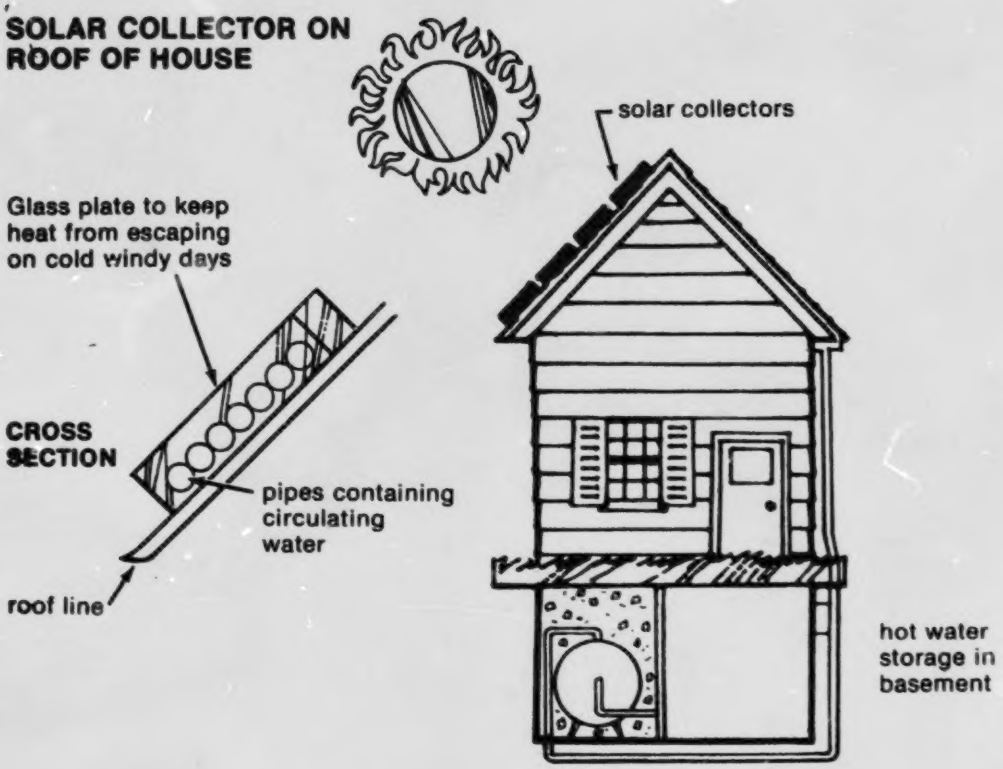
5. How could this affect other solar experiments?

6. Take two bags of the same color; repeat the preparation steps. Place one in full sun on insulation and one in full sun directly on the ground. Is there a difference in temperature after 15 minutes? ____________
Why? ____

Student Worksheet

ENERGY FROM THE SUN

One way to use solar energy is for each house, apartment or office building to collect enough solar energy to take care of its own heating, air conditioning, and water heating.



SOLAR COLLECTOR ON ROOF OF HOUSE

solar collectors
Glass plate to keep heat from escaping on cold windy days
CROSS SECTION
pipes containing circulating water
roof line
hot water storage in basement

1. What parts of the United States would be able to use solar heat without a conventional back-up furnace? ____________________

2. What side of the roof should the collectors be mounted on? ________

3. Why is the inside of some types of collectors lined with mirrors? ____

____

4. Will the heat from roof collectors be used to generate electricity? ___

5. Could photovoltaics (solar cells) be used to generate electricity? ____

6. The United States Department of Energy foresees as much as 25 per cent of our energy need filled by solar technologies by the year 2000. Will it take so long? ____ Why? ____________________

Source: United States Department of Energy

Student Worksheet

ENERGY FROM THE SUN
ANSWER SHEET

1. the south; southwest
2. the south side
3. to reflect and concentrate the rays of the sun
4. no
5. yes
6. technology; cost; setting research priorities

LESSON #15

CATEGORY: Sources

ENERGY TYPE: Direct Solar

TITLE: Clean and Renewable:
Water for Me!

GRADE LEVEL: 4-6

INFUSE WITH SUBJECT AREA:

TIME NEEDED: Two periods

Science
Social Studies
Math

MATERIALS

2 one-gallon jars (perhaps from cafeteria)
5 dutch-oven type pans
1 roll plastic wrap
10 cups
5 9x13 aluminum pans
Masking tape
Salt

OBJECTIVE:

The students will know that the heat energy from the sun can be used to purify water by a process of evaporation and condensation.

TASK ANALYSIS:

The students should be able to measure, observe, identify and control variables and record data.

PROCEDURE:

1. Preparation

   Read Teacher Background Information (15.3).
   Duplicate Student Worksheet 15.4.
   Assemble materials.
   Prepare one gallon muddy water.
   Prepare one gallon salty water (8 tablespoons salt to one gallon water).

2. Steps in Lesson

   Objective: The students will know that the heat energy from the sun can be used to purify water by a process of evaporation and condensation.

   a. Tell the students they are to pretend they are marooned on an island surrounded by the muddy Mississippi River. They have managed to arrive with food but no water. Suddenly they are very thirsty and the surrounding water is unfit for drinking. What can they do?

   b. Distribute Student Worksheet 15.4 (Quench My Thirst) and have the students work in groups of five to carry out the investigation. Help them to orient their pans so that the sun's rays strike them as close to right angles as possible.

c. Have the students work in their same groups and place about a quart of salty water in a 9 inch x 13 inch pan. Place a cup in the center of the pan, cover the pan with clear plastic wrap, tape to the pan, weigh it down with a rock. Place the pan of salted water in the sun. Allow it to evaporate and notice what is left in the pan. Have the students apply this to the oceans. (Heat from solar radiation causes the ocean water to evaporate and to rise into the atmosphere as water vapor. The water that goes into the atmosphere is pure water. It leaves the salt behind.) Currently, fans and heaters, machines that require fuel for their operations, are used in the evaporation of large amounts of water. Perhaps the students can think of alternatives for this process instead of using energy-demanding engines.

d. Tell the students that the Arkansas River is muddy and salty. It is not drinkable nor is it used for irrigation. Can they think of how this water could be made usable for drinking and irrigation?

3. Evaluation

Have the students list some disadvantages to using glass or plastic wrap over a large container of water that they are purifying. (hailstorms, rocks or some flying objects, sharp instruments, claws of animals, etc.) (This application of glass or plastic wrap would be too difficult to handle for large facilities.)

4. Follow-Up Activities

Have the students research the Chilean nitrate mine solar-powered installation of the 19th century. (There is some information on this historical use of solar in the Teacher Background Information.)

TEACHER BACKGROUND INFORMATION

SOLAR DISTILLATION

Making pure water from salty or muddy water is usually done by boiling and condensing the steam. The United States Navy makes pure water for its ships this way.

But there is another way that is an older method. The sun can be used to purify water. A solar still (device for distilling water) was built in 1872 and operated for forty years in the desert near Salinas, Chile, providing 6,000 gallons of fresh water daily for a nitrate mine. During World War II many fliers were shot down over the ocean. There was plenty of water but not a drop to drink until a portable clear plastic solar still was invented. It became standard equipment on life rafts and could produce a quart of water a day. Solar stills supply about 1,000 gallons of pure water per day for the people on the island of Saint Vincent in the West Indies. If more water is needed the people of Saint Vincent use the wind to speed up the condensation and evaporation processes. The still acts as a heat trap because the roof is transparent to the incoming sunlight, but it is opaque to the long infrared radiation emitted by the hot water.

In the two investigations in this lesson solar radiation heats the water through a transparent plastic cover. As the water accumulates into drops, they become heavy enough to fall into the cup. Impurities are solids which do not evaporate at low temperatures and remain in the pan. The limits of solar distillation are set by the heat of vaporization of water and by the amount of solar radiation.

Student Worksheet

QUENCH MY THIRST

1. What happens to water when it gets warm? ______________________________

2. What happens to steam when it gets cool? ______________________________

3. Can you guess (predict) what will happen to muddy water left in the sun?

4. Place 5 cm of muddy water in the pan. Place a cup in the middle of the pan and cover the pan with plastic wrap. Tape the plastic wrap to the pan to hold it in place.

5. Take a small weight (for example, a rock) and place it on the plastic wrap that is covering the pan. The plastic wrap will sag in the middle. Do not let the weight touch the cup.

6. Place the pan of muddy water in the sun for an hour. Should the pan be tilted or flat? ______________________

7. Explain what happens.

8. How much clean water did you collect in one hour? ______________________

9. If you had to tilt your pan of muddy water what direction did you direct the plastic wrap? ___________________

10. Can you think of a cycle in nature that is like this process? __________

11. What is the source of heat? ____

Student Worksheet

QUENCH MY THIRST
(answer sheet)

1. evaporates

2. condenses

3. (answers will vary)

6. tilted to the south

7. The water evaporates, collects (condenses) on the plastic wrap and runs into the cup.

8. About 5 ml of clean water can be collected from a liter of muddy water in one hour's time on a warm, sunny day. If the day is cool or cloudy it will take longer to get the 5 ml of clean water.

9. south

10. water cycle

11. the sun

LESSON #16

CATEGORY: Uses

ENERGY TYPE: Direct Solar

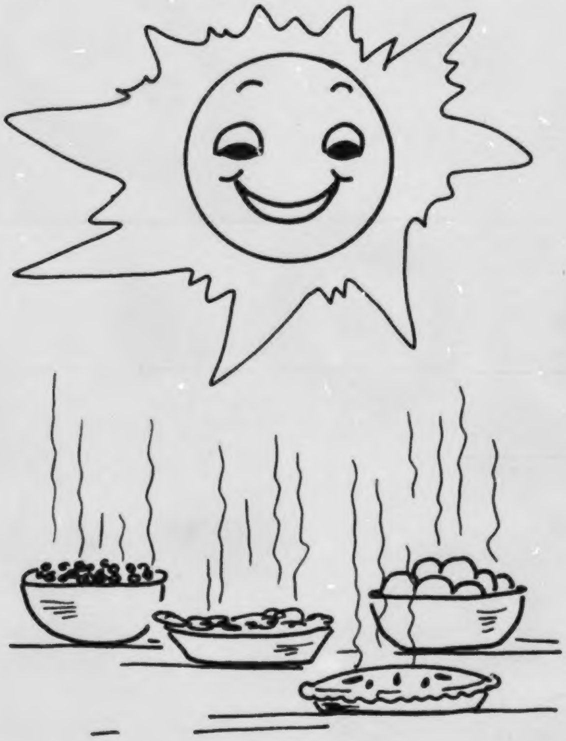
TITLE: Clean and Renewable: Sun Rays are Really Cooking!

GRADE LEVEL: 4-6

TIME NEEDED: Two periods

INFUSE WITH SUBJECT AREA:

Science
Home Economics
Language Arts



MATERIALS:

5 rulers
1 pint flat black paint
5 paint brushes
1 roll aluminum foil
5 quart jars with lids
10 tea bags
Napkins
Rubber cement
5 poster boards, 28 cm x 34.5 cm
5 scissors
15 cardboard boxes
10 small nuts
10 small bolts
5 unpainted coat hangers
10 sheets black construction paper
15 coat hangers
1 roll clear plastic wrap
Nylon screening
Tape
Knife
Duct tape

OBJECTIVE:

The students will know that the sun gives heat that can be concentrated and used by Arkansans.

TASK ANALYSIS:

The students should be able to work and study with other students following directions, constructing models, and experimenting.

PROCEDURE:

1. Preparation

   Read Teacher Background Information (16.4).
   Duplicate Student Worksheets 16.5, 16.7, 16.8, and 16.9.
   Gather above-listed materials.

2. Steps in Lesson

Objective: The students will know that the sun gives heat that can be concentrated and used by Arkansans.

a. Introduce vocabulary.

- Reflect: bounces off an object, with a change of direction, as light off a mirror

- Energy: the ability to do work; that is, to move

- Solar system: the sun and its planets and other bodies that revolve around it

- Absorb: to take up a substance, as a sponge takes up water

b. Ask the students if they have ever put their bare feet on a concrete sidewalk in hot weather. What happens to a concrete sidewalk on a hot summer day? Check to see what they think it means to hear that the sidewalk is "hot enough to fry an egg". (The sidewalk is made of tiny parts called molecules which are always moving. The energy from the sun hits the sidewalk and makes the molecules move faster. As the molecules move faster the temperature gets higher.) Ask the students what happens when they stay in the sun too long. (sunburned; the sun cooks their skin) Ask them if they can think of ways this heat from the sun can cook other things.

c. Divide the students into groups of 4 or 5. Give each group a ruler, paint brush, paint, and some aluminum foil. Have them paint the ruler with the flat black paint. Allow this to dry and wrap half of the ruler with aluminum foil. Place the ruler in the sun for an hour or so. Have the students collect the ruler and see if they can feel the temperature differences between the absorbing black surface and the reflecting aluminum surface. Develop the fact that the sun's energy is enough to make the concrete sidewalk hot to their feet and to cook their skin. Ask if they can think of ways to cook their lunch. Have the students think about it overnight and have each one bring a hot dog and bun from home for lunch the next day.

d. Divide the students into groups of 4 or 5 and distribute Student Worksheets 16.5 and 16.7 (A Special Solar School Lunch). Have them follow the directions, construct their solar cookers, cook their hot dogs, and make their solar tea. After lunch discuss with the students what they did and how effective they thought it was.

e. Have the students complete Student Worksheet 16.8 (Solar Tea vs. Boiling Water Tea) and discuss the results with them.

3. Evaluation

a. Have the students make a solar oven and plan to serve pizza, hot dogs, or donuts. Distribute Student Worksheet 16.9 (A Solar Oven) and have the students construct and plan to treat themselves.

b. Have the students list the advantages of solar cooking. (no warming up period, "free" fuel, available fuel any place the sun shines, cool cooking, no matches needed, no ashes or soot)

c. Have the students write their own directions for Building a Stove Made of Paper and Brewing Solar Tea. Be sure they write that the stove cooks with sun energy.

4. Follow-Up Activities

a. Distribute Student Worksheet 16.10 (A Treat, No Trick: Solar Dryer) and let the students take it home to construct a dryer and to dry fruit for a treat. As an optional activity, the students can do this at school.

b. See how many words the students can make with SOLAR COOKING. This language activity can also be expanded to include prefixes and or commercial names like Solarcaine. (soon, loon, rang, ring, king, sing, sling, lag, nag, rag, sol, oil, soil, etc.)

TEACHER BACKGROUND INFORMATION

SOLAR COOKING

The first solar cooker was constructed over 200 years ago by Swiss scientist Nicholas de Saussure (1740-99). It was made of wood, painted black on the bottom, and covered with plates of glass to trap the sun's heat. He found he could produce 191 degrees F. in full sunlight. It was praised as a practical way for soldiers to cook food when they were in the field. However, due to the availability of cheap oil, natural gas, and coal, they have not been used very often in the past.

When constructing a solar cooker, some general items to remember are:

1. Reflect as much of the sun's energy as possible.
2. Focus as much of the sun's energy as possible; accurate measuring of the focal points is necessary.
3. Keep the sun's rays approximately perpendicular to the cooking surface by tracking the sun.
4. Absorb the energy by using a flat, black-coated cooking surface.

Solar cookers use the sun's energy immediately while solar air and water heaters, solar ovens and solar greenhouses are designed to hold the sun's heat for an extended period of time.

The hot dog will cook in about fifteen minutes on a warm sunny day. Solar tea takes three to six hours to make.

Student Worksheet

A SPECIAL SOLAR SCHOOL LUNCH

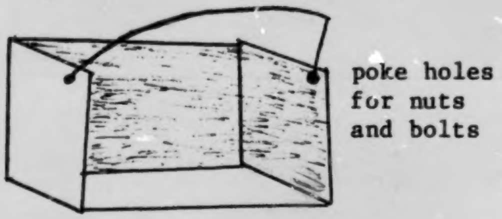
1. You will need your hot dogs, 2 cardboard boxes, 2 small nuts and 2 bolts, aluminum foil, unpainted coat hanger, scissors, rubber cement, tape, 28 cm x 24.5 cm poster board.

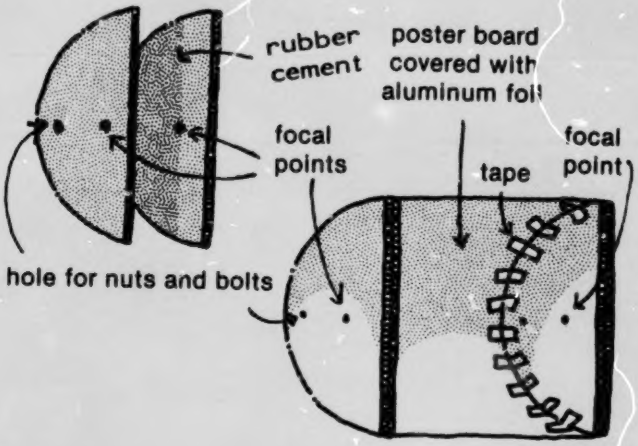
2. Cut the top and front out of one cardboard box to make a frame for your solar cooker.

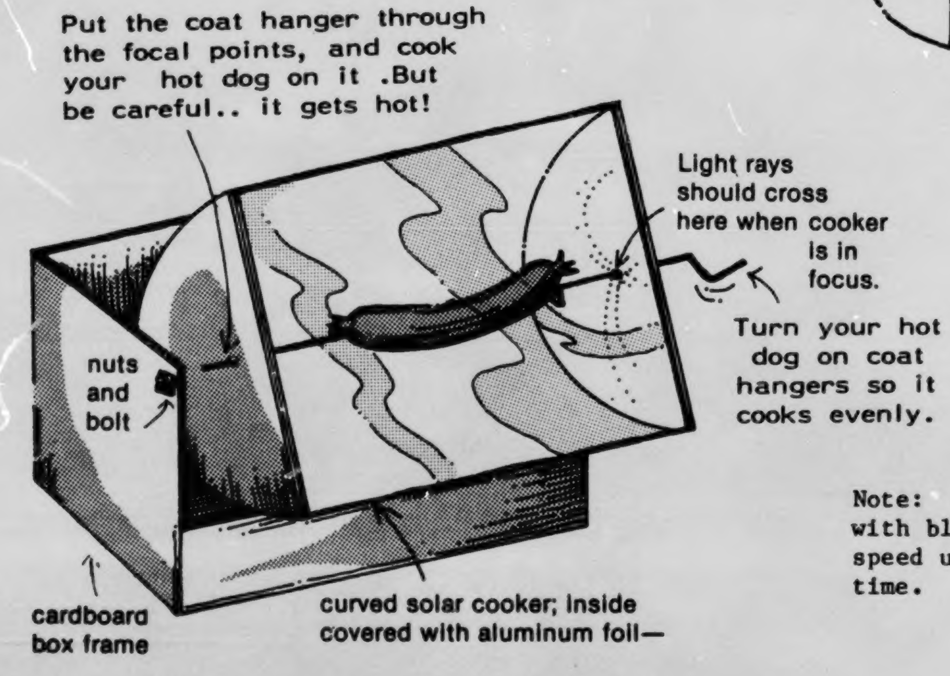
3. Use the pattern on the following page to cut 4 pieces from the other cardboard box. Cement 2 pieces together to make 1 that is twice as heavy.

4. Glue a smooth piece of aluminum foil to one side of the poster board. Tape the poster board to the two curved pieces. Attach the cooker to the frame using nuts and bolts.

5. Adjust the cooker so that you can see the sun's rays cross on the focal points.





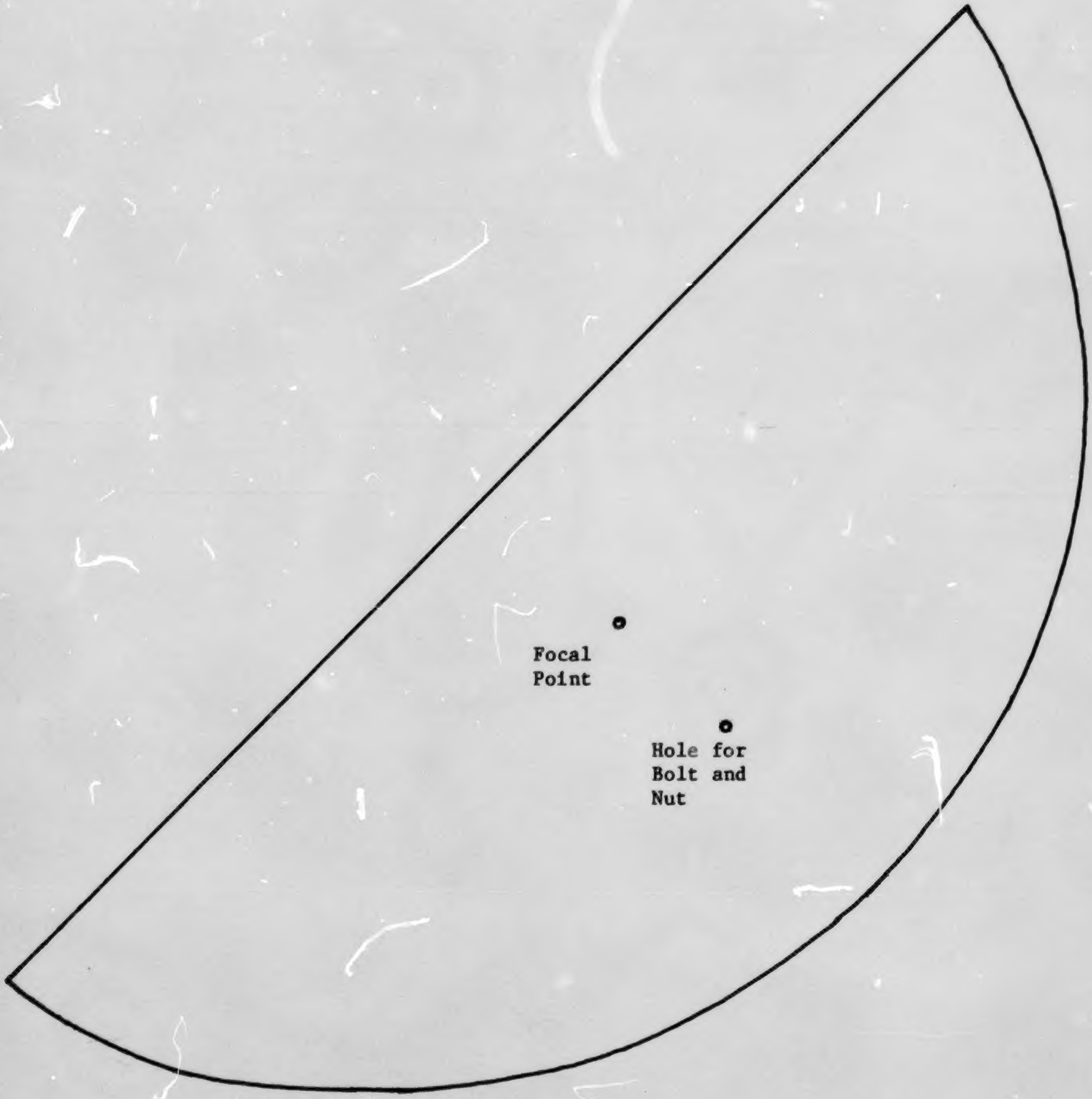

Put the coat hanger through the focal points, and cook your hot dog on it .But be careful.. it gets hot!
Light rays should cross here when cooker is in focus.
Turn your hot dog on coat hangers so it cooks evenly.
nuts and bolt
cardboard box frame
curved solar cooker; inside covered with aluminum foil—

Note: Cover hot dog with black foil to speed up cooking time.

Source: United States Department of Energy

Student Worksheet

A SPECIAL SOLAR SCHOOL LUNCH
HOT DOG COOKER PATTERN



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Student Worksheet

A SPECIAL SOLAR SCHOOL LUNCH

1. You will need a tea bag, a liter of cold water and a clear glass jar with lid.
2. Place a tea bag in a liter of cold water in the glass jar, place the lid on the jar, and then place it in the sun for a few hours.
3. Allow plenty of time for the tea to get the color you want. Take the jar inside, remove the tea bag, and let it cool to room temperature.
4. Enjoy your tea!

Student Worksheet

SOLAR TEA VS BOILING WATER TEA

1. Prepare a liter of tea by the solar method and another liter of tea by pouring boiling water over one tea bag and letting the mixture stand for about 5 minutes. Remove the tea bag and compare the two:

   a. Which has the richest color?

   b. Which is the clearest?

   c. Which has the preferred taste?

2. Store both samples in a refrigerator overnight and determine:

   a. Which has the richest color?

   b. Which is the clearest?

   c. Which has the preferred taste?

3. Take a liter of tea and a liter of plain water and record the temperature in both. Place both of them in the sun for 15 minutes. Which one got the warmest? __________ Why? ____________________________________

4. Place one jar of tea on a light surface such as a concrete sidewalk and one jar on a dark surface such as an asphalt pavement. Compare the temperatures after about 15 minutes.

Student Worksheet

ANSWER SHEET

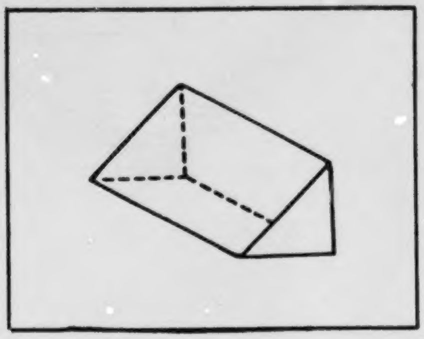
Answers for Student Worksheet 16.8

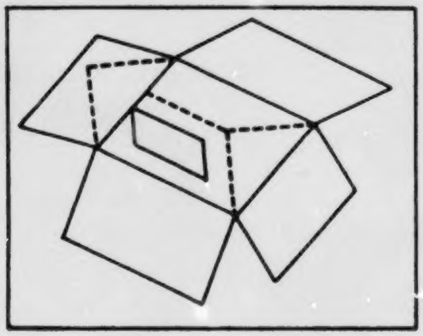
1. answers will vary
2. answer will vary
3. the one in the sun; darker color absorbs more solar energy
4. the jar on the asphalt pavement will reach a higher temperature

Student Worksheet

A SOLAR OVEN

1. You will need a cube-shaped (or near cube-shaped) cardboard box (70 to 100 cm on each side), flat black paint, clear plastic wrap, duct tape, knife, aluminum foil, and rigid plastic foam or cardboard.





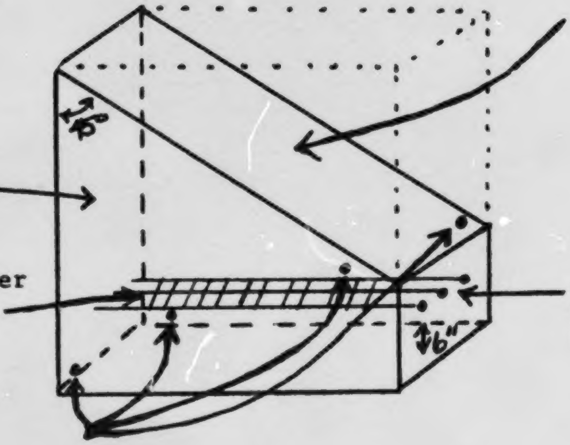
2. Cut away one side at an angle as shown in the above picture on the left. Paint the inside surface black.

3. Cover the angled front with transparent plastic and seal with duct tape. If the plastic sags, a fine strand or two of wire can be stretched across the opening before securing the plastic.

4. Cut a small entry door as shown in the above picture on the right in the back side to permit access to foods. Tape cardboard or foam flaps, covered with aluminum foil, in place. Angle the flaps to reflect extra sunlight into the oven.

Student Worksheet

A TREAT, NO TRICK: SOLAR DRYER



clear plastic wrap

box is lined with black paper

nylon screening over hangers forms rack

3 coat hangers form fruit rack 6" from bottom of box

ventilation slots on both sides of box, high and low

The sun can help us preserve fruit.
You will need a cardboard box, black construction paper, three coat hangers, clear plastic wrap and nylon screening to make a fruit dryer.

1. Cut the top off the cardboard box. Cut the front side leaving about 8 inches for the front wall.

2. Line the inside of the box with black construction paper (black paint can be used but the vapors need to be baked out before using).

3. Straighten three coat hangers, pass them through the box in a line to form a rack 6 inches from the bottom of the box. Place nylon screening over the hanger rack.

4. Place a vent hole in the bottom back corner of each side and one on each front side near the top. These vents allow the air to circulate in the box, thus drying the fruit out faster. The clear plastic wrap will allow the sun's energy in but detain the outgoing energy. Tape the clear plastic wrap over the box in such a manner that a surface with an angle of 45 degrees is made with the bottom of the box.

5. Place thin slices of apple, banana, or any fruit on the screening. The wetter the fruit, the longer it takes to dry.

   What are the differences between dried apples and canned applesauce? Which tastes better? Which would be easier to carry on a hike? Which uses more direct energy from the sun to make?

LESSON #17

CATEGORY: Sources

ENERGY TYPE: Hydro

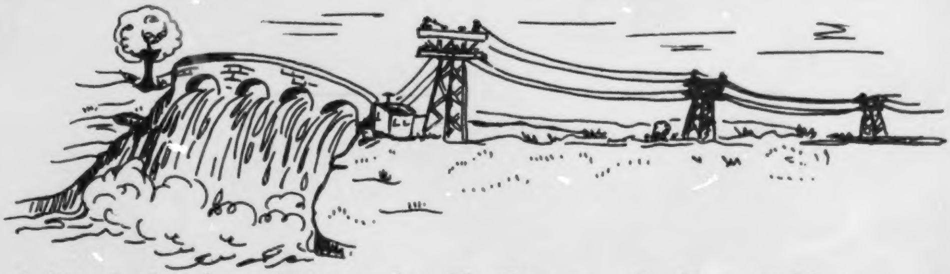
TITLE: Clean and Renewable:
Hydropower is Here

GRADE LEVEL: 4-6

INFUSE WITH SUBJECT AREA:

TIME NEEDED: Two periods

Social Studies
Science



MATERIALS:

Arkansas wall map

OBJECTIVES:

1. The students will define hydroelectricity and tell of some of its earlier uses.
2. The students will explain hydro generation of electricity.
3. The students will state pros and cons of hydroelectric generation.
4. The students will locate on a map of Arkansas some of the hydroelectric plants in the state.

TASK ANALYSIS:

The students should be able to use a dictionary; know map directions; be able to write sentences and paragraphs; spell correctly and punctuate accurately.

PROCEDURE:

1. Preparation

   Read Teacher Background Information (17.4).
   Duplicate Student Worksheets 17.5, 17.6, and 17.7.

2. Steps in Lesson

   Objective #1: The students will define hydroelectricity and tell of some of its earlier uses.

   Objective #2: The students will explain hydro generation of electricity.

   Objective #3: The students will state pros and cons of hydroelectric generation.

   Objective #4: The students will locate on a map of Arkansas some of the hydroelectric plants in the state.

   a. Have the students look up the meaning of the word "hydroelectricity" in the dictionary and write the meaning in their own words. (called indirect solar energy or a second hand solar source; harnessed water power to provide electricity)

b. Have the students research some of the earlier uses of hydropower in the United States. (All the water of the earth possesses energy, either kinetic if moving or potential if standing. Hydropower is one of man's oldest energy forms. The history of its use dates from Roman times. In the United States hydropower was used to drive grist mills, saw mills, textile mills and other manufacturing establishments during the 18th and 19th centuries.)

c. Distribute Student Worksheet 17.5 (How Power Plants Generate Electricity) and have the students study the diagram and answer the questions.

d. Ask the students what could be some environmental pros and cons of hydropower plants.

Possible Advantages:

- No air polllution

- Reduces dependency on foreign fossil fuels, thereby reducing negative environmental effects of mining for coal and drilling for oil

Possible Disadvantages:

- Often covers farm land

- Frequently destroys wildlife habitats

- Spoils free-flowing streams

- Sacrifices beautiful natural scenery

e. Distribute Student Worksheet 17.6 (Arkansas Streams) and 17.7 (Arkansas Hydroelectric Projects) and have the students locate these ten hydropower plants in Arkansas. They will need to refer to a wall map of Arkansas or a text map of Arkansas in order to locate the approximate project sites.

3. Evaluation

a. Have the students write poems, stories, or have a puppet show explaining "Dam Foolishness", "A Second Hand Solar Source", "Capturing Energy in Falling Water", or some unique title they may wish to share.

b. Challenge the students to research hydro and direct solar generation of electricity. Can they combine the two sources? What pollution problems will they have?

4. Follow-Up Activities

Arrange a class field trip to a hydroelectric power plant. Have the students note:

Different water levels (above and below the dam)

Age of the plant

Length of time it took to construct

Location of the turbines

Size of the power plant building

Number of generators

Size of the generators

Amount of noise

Flow of water after it goes through the generator

Reason for flood gates

TEACHER BACKGROUND INFORMATION

Flowing water was one of the first power sources for generating electricity, and it did so on a modest scale and with minimal environmental impact. In particular, the waterwheel, used since antiquity for grinding and pumping, was converted into a system to drive electrical generators. The water wheel was not particularly efficient in this service and modern turbogenerators which could withstand high water pressure replaced the old-time waterwheel. Huge dams were built to create this pressure and to supply the massive amounts of energy demanded by an expanding society and technology. Today, however, faced with soaring costs for fuel to power steam generators-and at the same time realizing the economic and environmental impracticability of large dams-engineers and others are earnestly investigating modern ways to tap the renewable energy in moving water without building gigantic dams. Some are studying using hydro without dams at all and retrofitting nongenerating dams such as on the Arkansas river.

A boost for the development of small dams came from a three-part legislative package from Congress. Low-interest federal loans would be available to encourage the redevelopment of existing small dams. Loans would be available to cover ninety per cent of the cost of individual feasibility studies. The third part of the package includes regulatory reforms which are designed to expedite and simplify the process of licensing small dams. This is also to get ground rules for the small producers so that they can buy and sell power from other utilities as supplies determine.

The legislation reflects a policy of diversified energy production. While supporters of hydroelectric power feel it is important not to expect more electricity than the small dams can provide, they note that even in times of low flow, this electricity can provide power for particular systems within a city--for street lights, public buildings or schools, as well as for single-site uses.

The additional energy produced by alternative hydroelectric sources would by no means eliminate the need for other power generation sources. Although the electrical generating capacity along United States rivers has increased steadily since 1920, it has not kept pace with the generating capacity of steam power plants. Whereas hydroelectric plants provided about one-third of the United States generating capacity in 1920, these plants represent only about thirteen per cent of the United States generating capacity today. Even if hydropower capacity were doubled, it would still be only a fraction of the total energy picture.

It is time to think of fulfilling energy needs with fractions and increments that fit together, complementing each other, to create the entire energy picture.

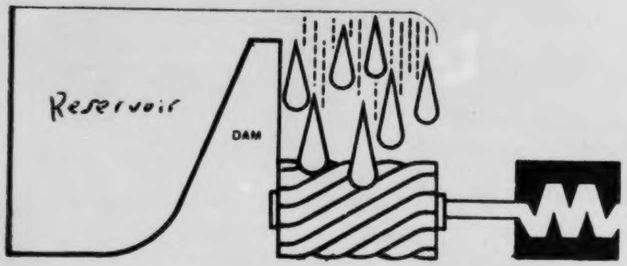
Student Worksheet

HOW POWER PLANTS GENERATE ELECTRICITY

Power plants, whether fueled by falling water, coal, oil, natural gas, wood, nuclear or some other type of fuel, produce electricity in the same fashion--by turning a turbine which operates a generator. The electricity is all the same.

A hydroelectric power plant uses the energy of falling water to turn the turbine and make electricity.

HYDROELECTRIC GENERATION



A.__________ B.__________

1. What is at A? ______________________________

2. What is at B? ______________________________

3. After the drops of water go through A and B what is made? ____________

____

Student Worksheet

ANSWER SHEET

HOW POWER PLANTS GENERATE ELECTRICITY

1. turbine
2. generator
3. electricity

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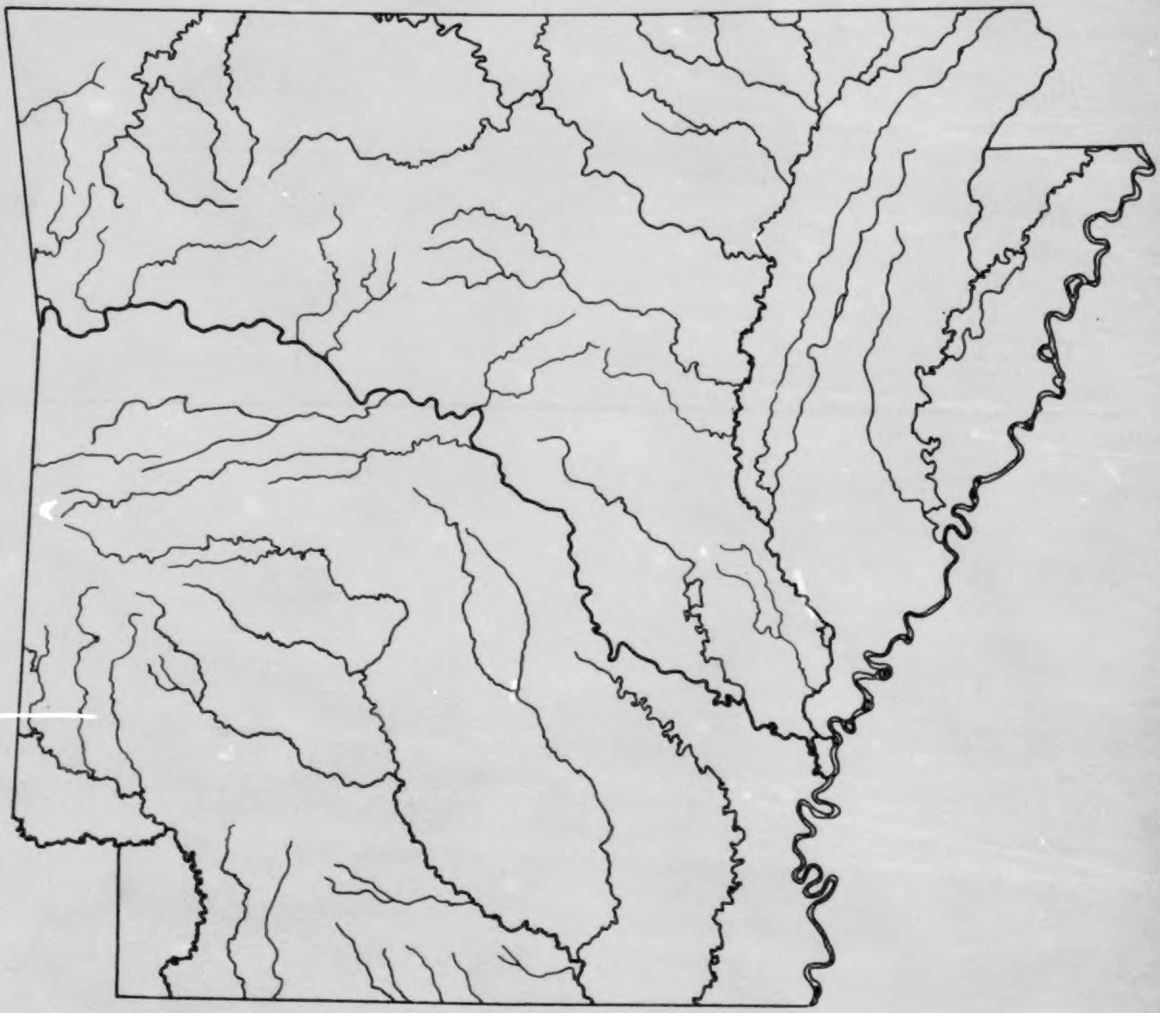
Student Worksheet

ARKANSAS STREAMS

Directions: Locate the hydroelectric projects listed on Student Worksheet 17.7. Note when each project started operating and how many kilowatts (KW) it can generate.



Student Worksheet

ARKANSAS HYDROELECTRIC PROJECTS

PROJECT	RIVER	LOCATION (COUNTY)	YEAR FIRST PRODUCED ELECTRICITY	EXISTING CAPACITY (KW)	ULTIMATE CAPACITY (KW)
1. Table Rock (dam in Missouri)	White		1959	200,000	200,000
2. Bull Shoals	White	Baxter-Marion	1953	340,000	340,000
3. Beaver	White	Carroll	1965	112,000	112,000
4. Norfork	North Fork	Baxter	1944	80,550	155,000
5. Ozark	Arkansas	Franklin	1973	100,000	100,000
6. Dardanelle	Arkansas	Pope-Yell	1965	124,000	124,000
7. Greers Ferry	Little Red	Cleburne	1964	96,000	96,000
8. Blakely Mountain	Ouachita	Garland	1956	75,000	75,000
9. Narrows	Little Missouri	Pike	1950	25,500	25,500
10. DeGray	Caddo	Clark	1972	68,000	108,000

LESSON #18

CATEGORY: Limits and Impacts

ENERGY TYPE: All

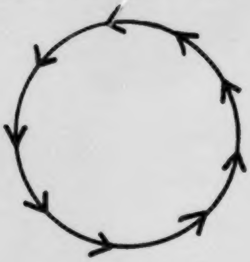
TITLE: U CAN S.A.V.E. (Save Arkansas' Vital Energy): Are you Recycling?

GRADE LEVEL: 4-6

INFUSE WITH SUBJECT AREA:

TIME NEEDED: Two periods

Consumer Education
Social Studies
Language Arts



MATERIALS:

Bicycle wheel

OBJECTIVES:

1. The students will recognize vocabulary words associated with recycling.
2. The students will know that recycling and reuse are alternatives to disposal.
3. The students will identify examples of "throw away" products being recycled.

TASK ANALYSIS:

The students should be able to follow oral and written instructions; be able to complete a task by listening; and be able to express themselves by using recycled materials for their art projects.

PROCEDURE:

1. Preparation

   Read Teacher Background Information (18.5).
   Duplicate Student Worksheets 18.6, 18.7, 18.8 and 18.9.

2. Steps in Lesson

   Objective #1: The students will recognize vocabulary words associated with recycling.

   Objective #2: The students will know that recycling and reuse are alternatives to disposal.

   Objective #3: The students will identify examples of "throw away" products being recycled.

   a. Introduce vocabulary terms:

      Waste - useless, unwanted or discarded materials

      Recycle - to collect and process waste materials into new useable materials

Natural Resources - raw materials, including land, water, timber, minerals, climate, soils, wildlife and other products of nature

Renewable - resources that potentially cannot be used up

Nonrenewable - resources that can be used up or at least depleted to such a degree that further recovery is too expensive

b. Ask the students what is waste? What are other names we have for waste? (garbage, trash, junk, refuse, rubbish, scrap)

Why do we identify some materials as nonrenewable? (Because they are the result of geological processes which take million of years to complete.)

Can we invent anything that does not use up natural resources? (This question can stimulate a challenging discussion promoting creative and divergent thinking. There is no "pat" answer.)

c. What materials do we find in our garbage? (paper, glass, metal, plastic, food) Where do these materials come from: Trace materials as follows: from paper to wood to tree to soil to earth (renewable); from glass to sand to pebbles to rocks to earth (renewable); from metal to rocks to earth (nonrenewable); from plastic to petroleum to fossil plants to earth (nonrenewable); from food to animals and plants to earth (renewable).

d. What are "resources"? (anything that is available for valued use or has plant, animal, or human utility.) Why are natural resources important?

e. Are our resources in endless supply? (no, they are not.)
Some examples:
aluminum cans from bauxite (nonrenewable); tin-plated steel cans from iron and tin (nonrenewable); glass bottles from sand, soda ash and limestone (nonrewable - currently in plentiful supply but it takes a lot of energy to produce them); paper from wood (renewable); plastic containers or bags from petroleum (nonrenewable).

f. What is meant by "throwing something away"? Where is "away"? How are waste products disposed of in our American society? (dumping, littering, burning, burying, recycling) Would rich people throw out different kinds of things than poor people? What about the junkman or the antique dealer? What is meant by the old saying "my trash may be your treasure"?

g. Write the word "recycle" on the chalkboard and ask the students what does the word mean? What are some other words that begin with the prefix "re"? (repair, redo, return, resource, renew, restore)

What does the word "cycle" mean? (to do or use over and over again) Refer to a bicycle wheel that goes around and around. Relate the natural, continuous recycling process that is going on, such as the nutrient cycle, oxygen cycle, water cycle and mineral cycle) Distribute Student Worksheet 18.6 (Always Going Around) and have the students complete.

What are some possible advantages of recycling? (reducing pollution, saving natural resources, saving energy, and saving money)

h. Distribute Student Worksheet 18.7 (Litter or Recycle?) and let the students find their way through the maze.

i. Share with the students the idea that recycling is not new. Ask them to give examples of recycling done in the past. (Using canning jars over and over; remaking clothes that are too short; repairing small appliances instead of throwing them away; using old car tires for a swing in the yard; using brown paper bags over and over to carry lunch in; using fireplace ashes for fertilizer and insecticides; cleaning the stalls at the barn and using for fertilizer; saving buttons from old clothes to use on newer clothes; saving all nuts and bolts and not having to run to the store to buy one every time one is needed; using old sheets to make pillow cases; saving old oil from the car and putting on the road to keep the dust down or on the wood fence post to preserve it; etc.)

j. Divide the students into small groups. Have each group list ten items that can be recycled now. Give examples of how the items are recycled and how many times they can be recycled.

k. Have the students take the outer packaging from purchased products such as toothpaste, gum, candy, etc. and arrange all these wrappings in an art display.

l. Distribute Student Worksheet 18.8 (Recycling Crossword Puzzle) and have the students complete.
Puzzle answers:

Down

1. metal
3. rust
4. home
7. tires
9. tree
10. rags

Across

2. earth
5. oil
6. rats
8. litter
11. energy

3. Evaluation

a. Have either individuals or small groups of students research and tell the life story of:

- an Aluminum Can
- a Plastic Tube
- a Cardboard Box
- a Tin Can
- a Glass Bottle

Give the students these suggestions to help tell about their particular resource:

What do I look like?
Why do I have a label?
What are some of the things I am used for?
What am I made of?
Where do my manufacturers get the raw materials to make me?
Are large amounts of my raw materials available?
How do manufacturers change the raw materials to make me?
Am I thrown away after I am used?

Do I break down into earth again if I am buried? If so, how?
What are some ways in which I could be reused?
Can I be recycled? Am I recycled? Where am I recycled?
What happens to me when I am recycled?
Who is responsible for disposing of me?
Do you think I am a good container? Why or why not?
Would I be in short supply as a result of an energy shortage?

b. Ask the students if they can name any perfect packaging materials? (ice cream cone)

4. Follow-Up Activities

a. Have the students participate in the Recycling Survey Questions (Student Worksheet 18.9) with their families and friends.

b. Ask the students to individually list three things each will do willingly to conserve energy.

c. Have a Recycling Roundup. Collect recycleable materials, such as aluminum cans. Invite other classes to help you or compete with them. Notice how they add up. Sell them and use the money for a class project.

TEACHER BACKGROUND INFORMATION

RECYCLING AND ENERGY

Source:
Arkansas Energy Office

Much energy is used to manufacture and process the items we buy. Products made from used or recycled materials generally take less energy than products made from new materials. For example, new aluminum uses 20 times as much energy as recycled aluminum, new paper uses twice as much energy as recycled paper, and man-made fabrics use 10 times as much energy as natural fabrics. Every ton of steel produced from recycled waste instead of raw ore does the following things: (1) saves enough energy to power the average American home for eight months, (2) eliminates 200 pounds of air pollutants, (3) reduces fresh water consumption by 6,700 gallons, (4) reduces wastes discharged into water by 107 pounds, and (5) eliminates about three tons of mining wastes. Throwing away one bottle wastes as much energy as a 100-watt bulb uses in four hours.

Recycling is not a modern concept. Pioneers recycled metal into buttons by taking old spoons and other pieces of worn-out tableware, melting them, and casting them in molds which had been cut into blocks of soapstone. Lemon and orange peels were also saved, dried, and used as a substitute for kindling wood. It not only revived a fire but also lightly perfumed a room. Old tin cans were used to patch leaky places in the roof and old newspapers have been succesfully used to insulate walls of houses.

Daily, Arkansans dispose of approximately 5,000 tons of solid waste. This includes such things as garbage, trash, street refuse, construction wastes, and dead animals. Recycling some of the materials is one way to re-use the resources and conserve energy. Recycling is one type of resource recovery. Another kind of resource recovery is called energy recovery.

To recover the energy, solid waste is placed in an incinerator which burns the waste. The energy released from incineration is used to produce steam, hot water or hot air. Many industries can use the hot air, hot water or steam in the place of electricity, gas, or oil to make their products. Siloam Springs, Arkansas, the first city in the United States to use a small incinerator, burns the waste at medium temperatures with a controlled amount of air so that they do not produce air pollution as some incinerators do.

Burning the waste reduces the volume of the waste by 85 per cent to 90 per cent. It can then be taken to a landfill, where it does not take up so much space and will not cause pollution. In some cases the ash can be used as road bed or fill materials.

The fuels which we have used for our personal needs have also taken us into the space age. These fuels, however, are rapidly being exhausted. At several times in history we have located new sources of energy and approached them with the idea that the supply was inexhaustible. Now we are beginning to realize that the earth is limited in its ability to satisfy our demands.

Student Worksheet

ALWAYS GOING AROUND

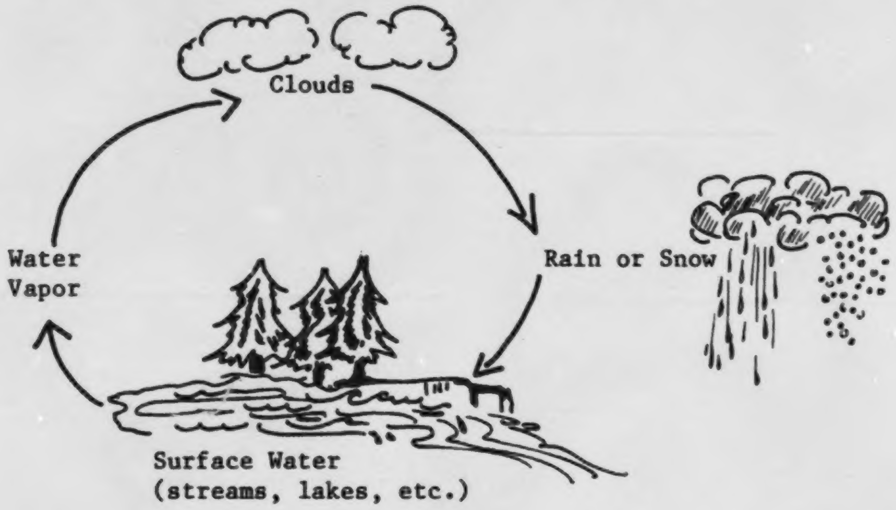
1. What does the word "recycle" mean? Write down your first thoughts.

   ____

2. Get your dictionary and look up the word. Write the definition in your own words.

   ____

3. Do you know of any cycle that is going on near you right now? __________ Look at the circle below and see if you can guess what cycles are taking place now. Remember this cycle is necessary for you to live.



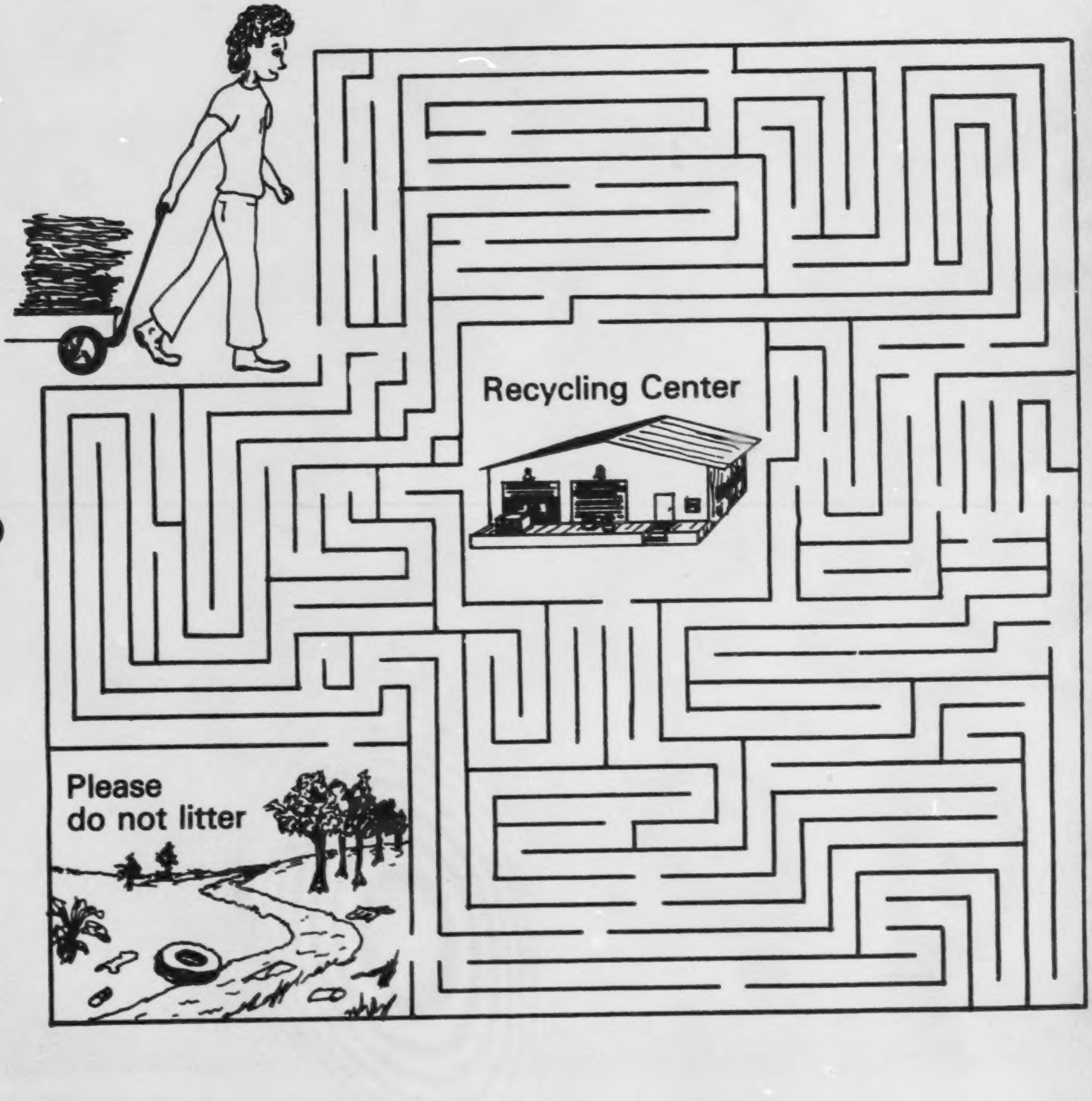
4. Draw a circle of some natural, continuous recycling process that you know of that is going on now.

5. Draw a circle of something you use that is recycled.

Student Worksheet

LITTER OR RECYCLE?

THE DIFFERENCE IS A-MAZING!



Source: Environmental Protection Agency

Student Worksheet

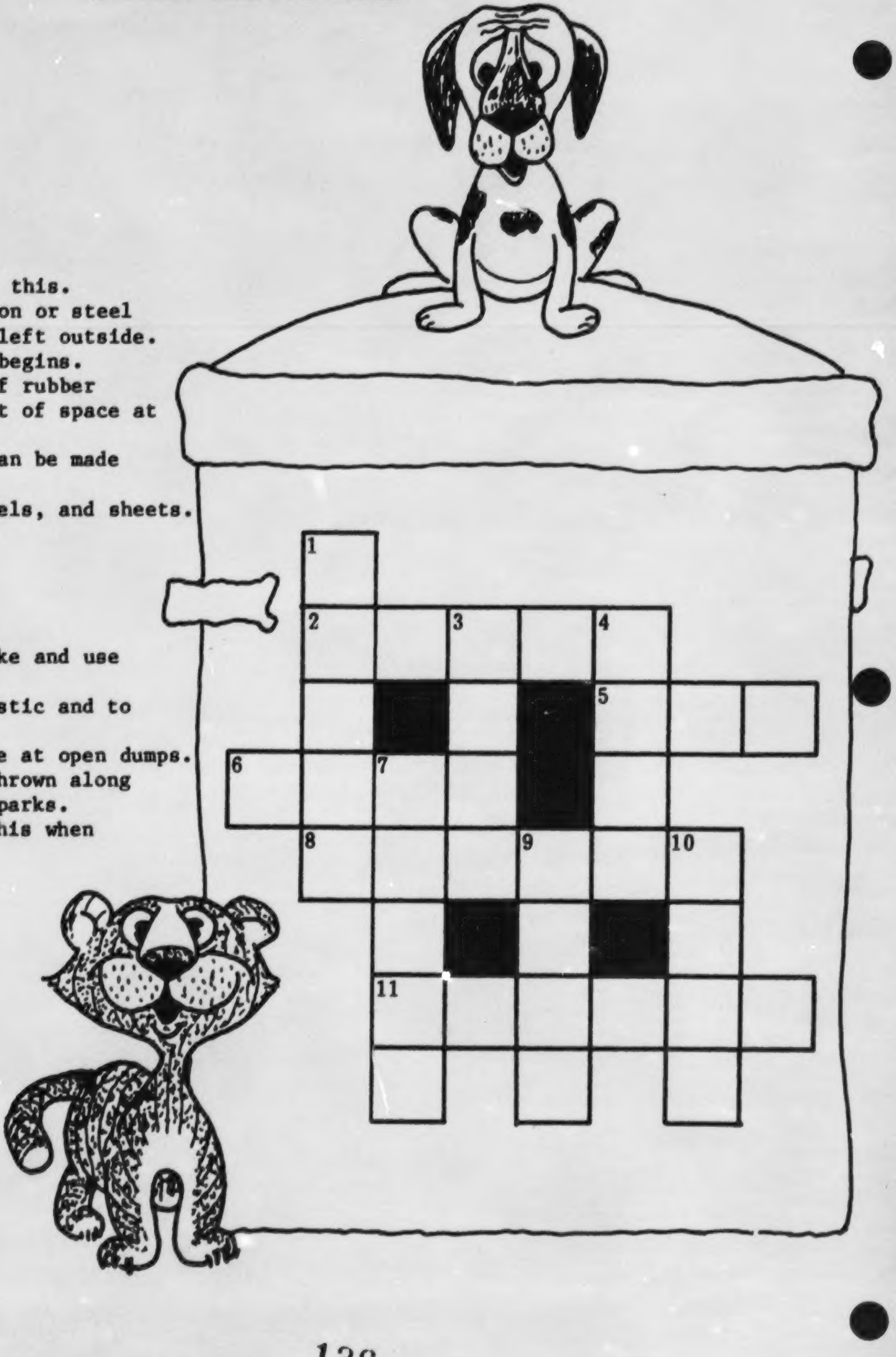
RECYCLING CROSSWORD PUZZLE

Down

1. Cans are made of this.
3. Items made of iron or steel will do this if left outside.
4. Where recycling begins.
7. These are made of rubber and take up a lot of space at disposal sites.
9. A lot of paper can be made from one.
10. Old clothes, towels, and sheets.

Across

2. Everything we make and use comes from here.
5. Used to make plastic and to run machines.
6. They like to live at open dumps.
8. Trash which is thrown along highways and in parks.
11. We can produce this when we burn waste.



Source: Environmental Protection Agency

Student Worksheet

RECYCLING SURVEY QUESTIONS

1. Will you recycle? At home? At school?

2. Why will you recycle? Why not?

3. What will encourage you to recycle?

4. Which is most important to you about recycling:

   Saving money?

   Reducing pollution?

   Saving natural resources?

   Saving energy?

LESSON #19

CATEGORY: Uses

ENERGY TYPE: Direct Solar

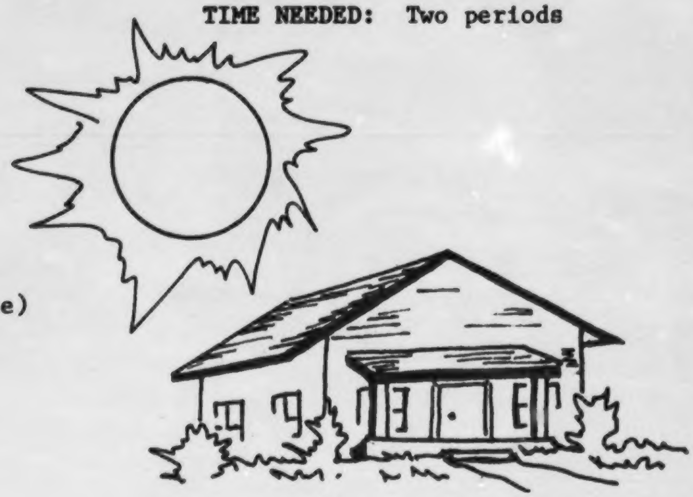
TITLE: Clean and Renewable:
Solar For Our Homes

GRADE LEVEL: 4-6

TIME NEEDED: Two periods

INFUSE WITH SUBJECT AREA:

Science
Social Studies
Language Arts



MATERIALS:

5 compasses
5 shoe boxes
10 cardboard boxes (all the same size)
White paint or paper
Paint brushes
10 thermometers
Roll of clear plastic wrap
Masking tape

OBJECTIVE:

The students will know the sun's rays can be used to heat their homes.

TASK ANALYSIS:

The students should be aware of their surroundings, be able to work with others and follow oral and written instructions.

PROCEDURE:

1. Preparation

   Read Teacher Background Information (19.3-19.5).
   Duplicate Student Worksheets 19.6, 19.7, 19.8.
   Gather above-listed materials.

2. Steps in Lesson

   Objective: The students will know the sun's rays can be used to heat their homes.

   a. Ask the students what type of fuel is used to heat their homes? Is the heating fuel scarce? Ask if they have ever heard of heating with the sun. Tell the students they are to decide if a solar home is practical, and if so, to name some of the advantages.

   b. Have the students use the compass and decide what direction is south.

c. Distribute Student Worksheet 19.6 (A Passive Solar "House"). Divide the students into small groups and let them do the investigation at the top of the page. Discuss the results with them.

d. Let the students do the second half of Student Worksheet 19.6 (North or South Windows?). Ask the students if they think an overhang shading the windows would affect the amount of sunshine in the windows at different times of the year.

e. Introduce the students to the two types of solar systems: passive and active (see Teacher Background Information).

3. Evaluation

Distribute Student Worksheet 19.7 (An Active Solar House) and have students write a paragraph explaining how the house is heated, and how the heating system differs from that of their cardboard "houses".

4. Follow-Up Activities

Build a Solar Greenhouse. Distribute Student Worksheet 19.8 (A Solar Greenhouse) and encourage the students to take the plans home, follow the directions, build a solar greenhouse, and raise fresh vegetables all year. Periodically have the students report on their greenhouse products and how they are helping to cut down on the food budget at home.

TEACHER BACKGROUND INFORMATION

Direct Solar Energy: Milking Sunbeams

Source:

Paul L. Butt. Arkansas and Energy. Arkansas Ecology Center: Little Rock. 1979.

To harness direct solar energy, the sun's radiation is collected and concentrated and then used for hot water heating, space heating, and space air conditioning, or converted to electricity using solar cells. Direct solar energy has an impressive array of advantages over other energy sources. It is an essentially unlimited and readily available energy source. The amount of solar energy that reaches the earth's surface in two weeks is equivalent to the energy in all know fossil fuel reserves. Direct solar is the cleanest and safest of all energy sources. With solar energy the major release of heat occurs in the sun, thus avoiding heat build-up in the atmosphere. No major breakthroughs are needed to make direct solar energy technologically feasible. The major impediment at present is its economic feasibility--or at least its perceived economic feasibility.

Along with its many advantages, direct solar energy has some problems. The solar energy falling on the earth's surface is so widely dispersed that collecting and concentrating it present difficulties. Concentrating it slightly to heat water and buildings is sensible, but concentrating it to high-temperature heat yields negative net useful energy. Or to say it another way, more energy (and money) has to be put into the system than can be gotten out. Like most dispersed, or decentralized, energy technologies, direct solar energy is resource intensive (copper, aluminum, glass). The mining, transportation, and refining of these materials all entail some negative environmental impacts. There is a price associated with every energy alternative. Even the technologies used to capture solar energy do not offer a "free lunch".

Throughout northern Arkansas solar energy can provide 60 to 80 per cent of the residential space heating requirements. Throughout the southern half of the state solar can provide 70 to 100 per cent of the home space heating needs.

The fuel (sunlight) is free, but the collecting and backup equipment can be quite costly initially. But in terms of lifetime cost, direct solar energy is economically attractive in Arkansas. This long-term economic advantage will increase as fossil fuel and nuclear power prices rise.

Passive Solar Systems

Direct solar energy can be utilized by either passive or active systems. A passive solar heating system uses solar heat directly and is the simpler method to use. A passive system relies upon natural energy flows and upon a building's design, composition, and site to capture and store the solar energy rather than upon a mechanical array of fans, pumps, and special collectors. A typical passively-heated house is tightly constructed and well insulated, with structural components throughout that are massive in order to retain heat, and with double-glazed windows on the south side and few (if any) windows on the north. The south-facing windows also have an overhang which permits the low sun to enter in the winter but does not permit the high summer sun to enter.

Easily movable insulating panels cover the windows at night to retard loss of the heat stored in the bulding's walls and floors during the day. During hot weather the panels are closed during the day and opened at night.

Passive solar heating is adapted to use in Arkansas where the winter temperatures are generally not too extreme. Other passive solar approaches suitable for use in Arkansas include reducing temperature variations by storing the solar energy in special south-facing, heat-storage walls, composed of concrete, rocks, water-filled barrels, or anything which is capable of storing large amounts of heat; and attaching a greenhouse to a building to serve as a solar collector as well as to grow plants.

Passive systems can be used in new construction or a home can be "retrofitted" with a passive system. Many Arkansas architects are now becoming active in drawing plans to take passive advantage of abundant solar energy.

If a house is to be newly constructed and the plans are chosen carefully, adding passive solar energy should add no more than ten per cent to the original cost of the structure. Using a well-designed passive system, an Arkansas homeowner can save from 80 to 90 per cent of his heating costs and also substantially cut his/her cooling costs.

Active Solar Systems

An active solar heating system collects heat (solar energy) outside a building and transfers it mechanically, with fans or pumps, inside the building through pipes and ducts. An active system is usually more expensive than a passive system. A wide variety of active solar heating equipment is available to the Arkansan. Such equipment can usually be used for both water and space heating.

The three major components in an active system are the solar collector, the heat storage unit, and the heat distribution network. Solar heat is collected by absorber panels in the solar collectors, which can be flat-plates, concentrators, or evacuated tubes. The collectors can be mounted on the roof, on the south wall of a building, or on their own supporting structure. Flat-plate collectors are well-insulated shallow, rectangular boxes. They contain metal plates coated with a black heat-absorbing substance, and are enclosed by glass or plastic transparent covers that trap the absorbed heat. Transferred to air or a water and antifreeze solution circulating in pipes behind the collectors, this heat is blown or pumped into the heating system's ducts. Or the heat is stored in a large bed of rocks or an insulated hot water tank for release at night or during cloudy weather.

Concentrating collectors attain higher temperatures than flat-plate collectors by using mirrors or lenses to focus the rays of the sun. But due to their more elaborate design, concentrating collectors are more expensive than flat plates. Evacuated tube collectors also reach higher temperatures than flat plates, and are more economical than concentrators. Evacuated tube collectors are generally considered the "up and coming" design in active solar systems. The outstanding feature of the evacuated tube design is the thermal absorbing vacuum tube. Each vacuum tube consists of one glass cylinder inside another. The space between the tubes is evacuated to form a "vacuum bottle". A copper tube coated with a highly efficient, heat-absorbing substance enters and leaves each vacuum tube carrying a heat transfer fluid.

For heating hot water, a solar collector using water as a heat transfer medium is superior to a collector using air as a transfer medium. The specific heat of water is many times greater than the specific heat of air; therefore the volume of air required to heat a given volume of water is much greater than the volume of water required to heat that same volume of water. Thus, a liquid heat transfer medium should be used to heat hot water in order for the system to perform more economically.

Most active solar heating systems are controlled by thermostats. Active systems are usually used in conjunction with conventional systems which serve as a backup to the solar equipment. Equipment sizing of both collectors and storage systems is important, both in terms of system cost and the potential contribution of solar for a particular building. Like passive systems, active systems can be used in new construction or an exisitng building can be "retrofitted" with an active system.

Student Worksheet

A PASSIVE SOLAR "HOUSE"

Investigation I: COMING THROUGH THE WINDOWS

1. Do you think it would make good sense to use as much of the sun's rays as we can? ____________ as often as we can? __________________

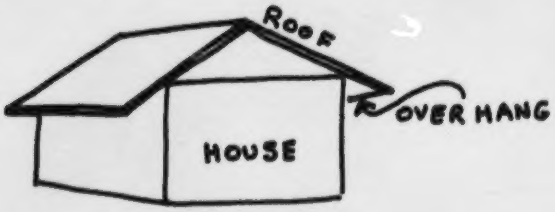
2. To build a cardboard "house" you and your partners will need a shoe box, clear plastic wrap, thermometer, and tape.

   Take the clear plastic wrap and tape it across the open top of the shoe box. Keep the plastic wrap as smooth and wrinkle-free as possible. Punch a small hole in one end of the box, and put the thermometer in it.

3. Place your cardboard "house" in the sunniest place you can find with the "front" facing the sun. What happened? ______________________________
   ____

4. Repeat the experiment but, this time, place a piece of cloth over the plastic "window". This is like a window curtain or shade. What happened?
   ____

5. How can the sun help heat your home in the winter? ____________________
   ____



Investigation II: NORTH OR SOUTH WINDOWS?

1. You and your group will need two cardboard boxes, white paint or paper, 2 thermometers, clear plastic wrap, knife, and masking tape.

2. Cut a large hole in one side of both boxes. Cover the holes with clear plastic wrap and tape it tightly over the holes. Paint both boxes white or cover both with white paper. Put a thermometer in each box. Place one box in the sun with the window facing the sun and the other with the window facing away from the sun. Record the temperature after ten minutes, after twenty minutes, and again after thirty minutes.

3. Which side of a house should have the most windows to help in heating the house?

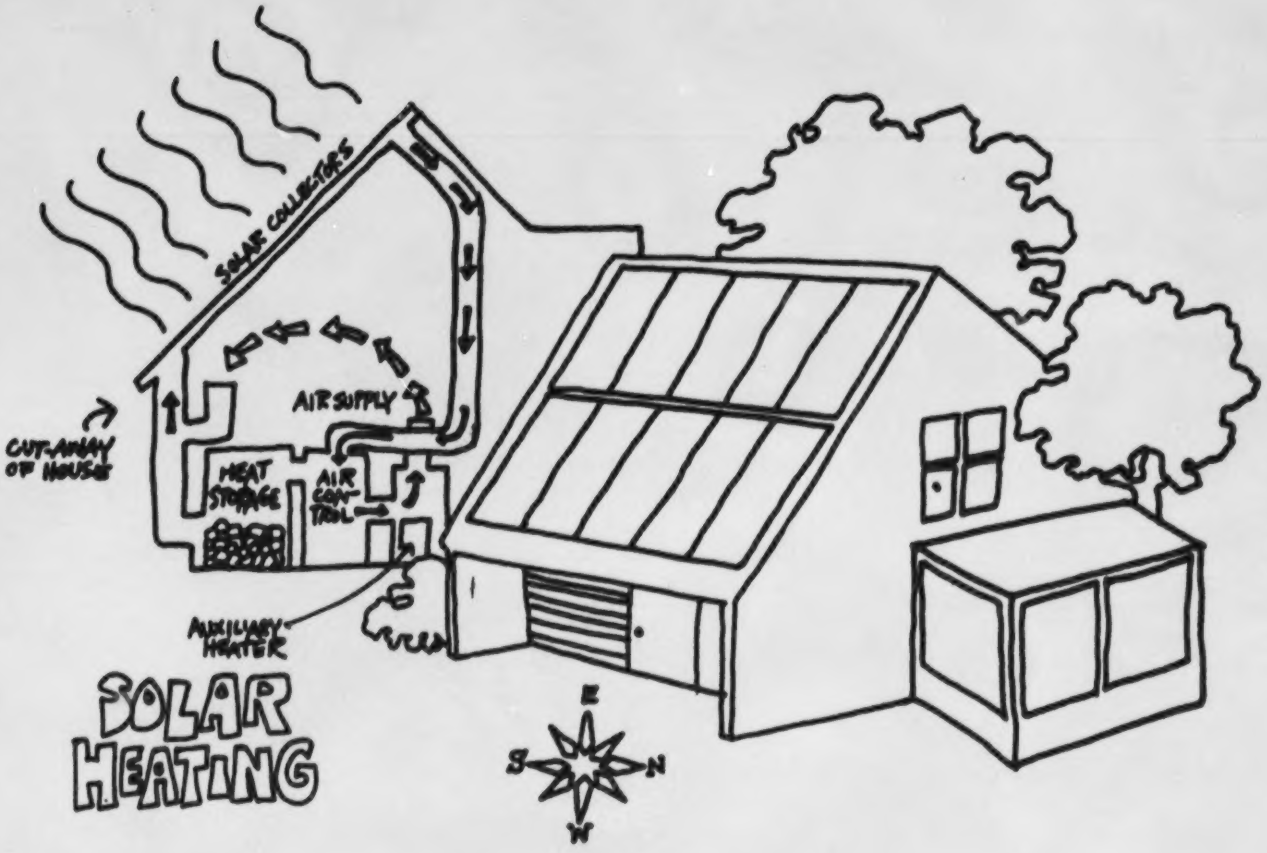
4. If you repeated this investigation at a different time of the day would the results be the same?

5. Add an overhang to both houses and check the thermometers to see if there is a difference. How could an overhang help cool the house in the summer?

Source:

Student Worksheet

AN ACTIVE SOLAR HOUSE



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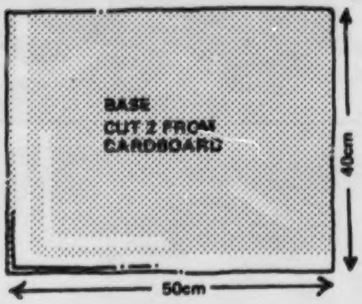
Source: United States Department of Energy

Student Worksheet

A SOLAR GREENHOUSE

You will need a cardboard box, clear plastic (3 or 4 mil, 50 cm x 450 cm), flat black spray paint, white spray paint, two thermometers, clear plastic wrap, tape, string or thread, tin cans, rubber bands, and insulation material (styrofoam, cardboard, newspaper, etc.)

1.



2.

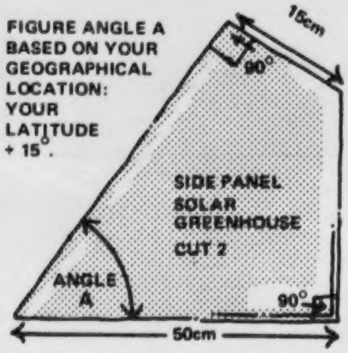
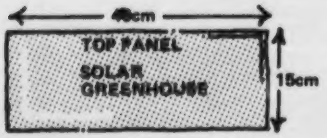


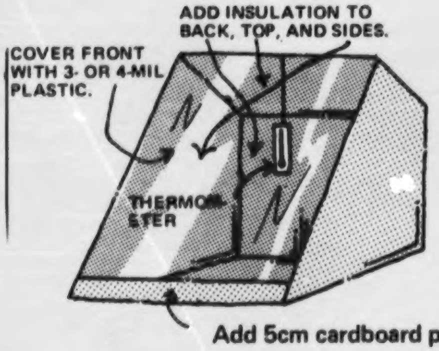
FIGURE ANGLE A BASED ON YOUR GEOGRAPHICAL LOCATION: YOUR LATITUDE + 15°.
15cm
90°
SIDE PANEL
SOLAR GREENHOUSE
CUT 2
ANGLE A
90°
50cm

3.



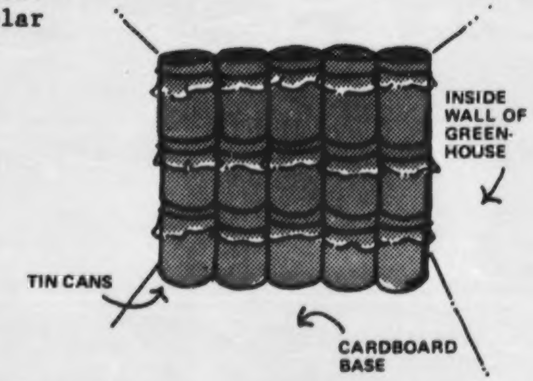
Spray the outside of the greenhouses white before adding plastic.

4.


ADD INSULATION TO BACK, TOP, AND SIDES.
COVER FRONT WITH 3- OR 4-MIL PLASTIC.
THERMOMETER

Add 5cm cardboard panel for stability.

5. Spray the cans flat black.
   Fill with water and cover tightly with plastic wrap and rubber bands.
   Stack them in the back of the solar greenhouse.



LESSON #20

CATEGORY: Uses

TITLE: U CAN S.A.V.E. (Save Arkansas' Vital Energy): Wheels on the Go

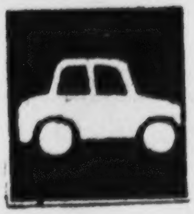
ENERGY TYPE: Oil, Gasoline

GRADE LEVEL: 5-6

TIME NEEDED: Two periods

INFUSE WITH SUBJECT AREA:

Science
Social Studies
Consumer Education
Math



MATERIALS:

Newspaper "want ads"
Car advertisements

OBJECTIVES:

1. The students will know the basic purpose of transportation.
2. The students will identify oil as the raw material for transportation fuel.

TASK ANALYSIS:

The students should be able to follow sequential steps and report orally to the class.

PROCEDURE:

1. Preparation

   Duplicate Student Worksheets 20.6, 20.7, 20.8, 20.9, and 20.10.
   Read Teacher Background Information (20.4 and 20.5).

2. Steps in Lesson

   Objective #1: The students will know the basic purpose of transportation.

   Objective #2: The students will identify oil as the raw material for transportation fuel.

   a. Ask the students how did you get to school today? How do you visit relatives? How do you take vacations? How does the mail get from Texas to Arkansas? from France to Arkansas? How did the food we had at lunch get to the school cafeteria?

      Develop with the students' responses the idea that transportation is used to move people and things from one place to another.

      Write the following sentence on the chalkboard and have the students copy it and fill in the blanks:

      Transportation is (moving) (people) and (things) from one (place) to another.

b. Distribute Student Worksheet 20.6 (Developing Transportation for People and Products) and have the students complete.

c. Distribute Student Worksheet 20.7 (The Story of Olivia Oil) and have them read the story looking for:

- Where do we find oil? (in the ground, under the sea)
- Is it found everywhere or just in special places? (special places)
- What kind of transportation is used to move oil across the ocean? (oil tankers)
- How is oil moved on land? (pipeline, tanker trucks, tanker trains)
- What is oil called at the place where it is being pumped out of the ground? (crude oil)
- What new names do we use for oil after it has been refined? (gasoline, heating fuel or oil, diesel fuel, kerosene, etc.)
- Do we use a lot of oil in our daily lives? (yes, not only in the transportation industry but also for recreational items, pharmaceutical goods, household goods, etc.)

d. Distribute Student Worksheet 20.8 (Reporter-on-the-Street Corner) and Student Worksheet 20.9 (Annual Fuel Costs Chart) and have them assume the role of a reporter and find out why people buy the cars they do. Have the students refer to the fuel costs chart and be able to tell the person they are interviewing how much his/her gasoline bill will be for a year if the cost is between 80 cents and $1.40 per gallon.

e. Make a chart containing the information the students have collected and discuss this information with them. Have them note what cars use the most gasoline and what used cars are listed in the newspaper for sale.

3. Evaluation

Quiz students to determine if they have grasped the link between oil and transportation and the energy crisis.

4. Follow-Up Activities

a. Have students complete Student Worksheet 20.10 (There Are Other Ways To Get From Here To There)

b. Do research on walking and see what benefits, other than lowered transportation cost, can be obtained. (opportunity to see scenery; chance to meet and visit with others; improved health; time to think and plan ahead; etc.)

TEACHER BACKGROUND INFORMATION

Transportation, the conveying of someone or something from one place to another, is now recognized as an enormous drain on the world's energy resources. Yet we cannot do without it. Throughout most of human history, animals have trod and wheels have turned from horse to horsepower, from wagon to automobile. This evolution has been taken for granted because most of us considered the supply of inexpensive fossil fuel energy limitless.

Still there is a limit to this energy supply, and we must find ways to conserve it. Because transportation is an "energy eater", strategies to encourage conservation in the transportation sector are especially important. The key to success is cooperation and careful planning. A world on the move has to know where it is going.

Transportation patterns throughout the world have changed dramatically during the past 200 years since the first steam engine was developed by James Watt in 1776. From foot power and horse and other animal power we have moved to energy intensive two-ton automobiles, jet airplanes, even space vehicles. Little more than a hundred years ago, we depended entirely on human and animal energy, wood, and coal to move people and goods from one place to another. However, two events that happened within two years of each other changed the course of the world.

In 1859, the first oil well was put down in Pennsylvania and in 1860 the first practical internal combustion engine was produced in France. By the early years of the twentieth century, trains, automobiles, and airplanes were powered by petroleum.

Today the transportation sector accounts for one-quarter of the total United States energy consumption and 60 per cent of the total United States petroleum consumption. These are direct costs only for gasoline, diesel and jet fuel, and motor oil. If all the indirect costs--which include vehicle manufacturing, fuel refining, road building, extraction of metals and other raw materials--were added, the total United States energy consumption for transportation would be much greater than 25 per cent.

Motor vehicles use about three-fourths of all the transportation energy. There are 100 million automobiles in the United States and more licensed drivers than there are registered voters. Statistically, two new cars are produced for every American baby born each day. Motor vehicle industries employ one out of every six American workers.

Conservation, in the transportation sector, more than in any other area of our life, can achieve immediately observable results in important energy savings. If, for example, the fuel consumption of every car in the nation were reduced by 50 gallons of gasoline each year--only one gallon a week--we could save seven per cent of the total demand for gasoline. This has already been proven. With only moderate conservation (minimal, even) Arkansas used approximately six per cent less gasoline in 1979 than in 1978. With strong conservation the percentage could be startling. Conservation practices such as greater engine efficiency (more miles to the gallon), more passengers per car, better driving practices, and regular maintenance can mean fuel efficient means of transportation. Bicycling, walking, public transportation can effect even greater energy savings. We can travel short distances between cities by rail or by bus, rather than by plane or private automobile.

Student Worksheet

DEVELOPING TRANSPORTATION FOR PEOPLE AND PRODUCTS

Instructions: Study the picture history of transportation in the chart below. Now match the captions below with the correct pictures by putting the correct letter from pictures in the space ( ) next to the caption. Next, cut out the pictures, paste them in order from the earliest history to the present time.

---

1. ( ) Wright Bros. Airplane 1903
2. ( ) Prehistoric Log Boat
3. ( ) Hot Air Balloon 1783
4. ( ) First Gasoline Powered Car 1893
5. ( ) Model T Motorcar 1920
6. ( ) Full rigged sailing ship 1865
7. ( ) Egyptian boat with sails and oars — 4700 BC
8. ( ) Modern car and trailer
9. ( ) Primitive Wagon
10. ( ) Locomotive (Steam) 1940
11. ( ) First steam boat 1803
12. ( ) Modern jet airliner
13. ( ) Horse drawn stagecoach 1800
14. ( ) Helicopter 1960's
15. ( ) Two engine transport plane 1940
16. ( ) Early Bi-plane 1915
17. ( ) Aluminum Hydrofoil boat 1970's
18. ( ) Lunar Module approaching Moon
19. ( ) Modern Diesel oceanliner
20. ( ) Primitive pack animal

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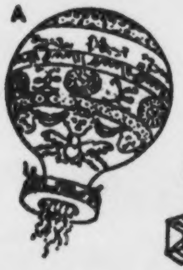

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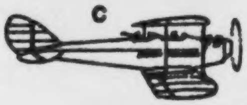

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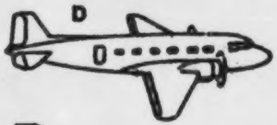

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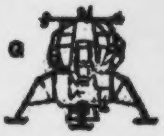

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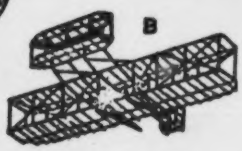

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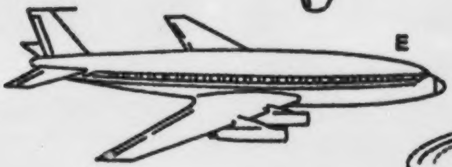

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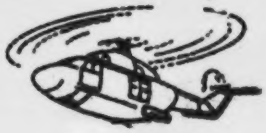

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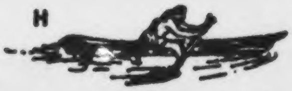

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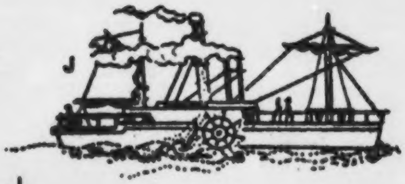

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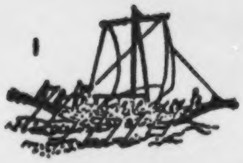

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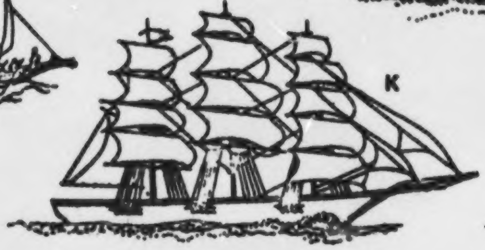

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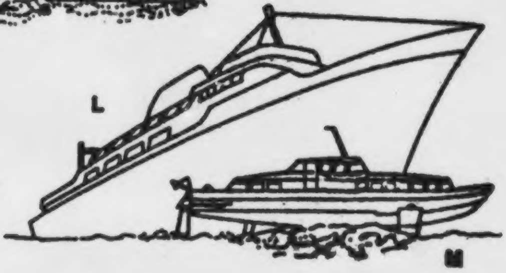

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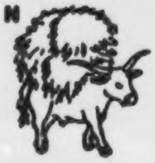

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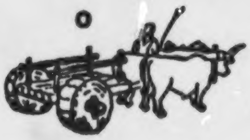

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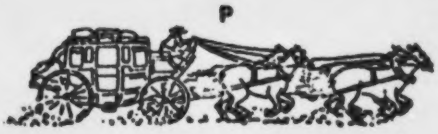

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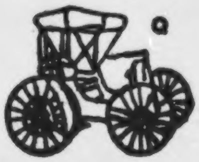

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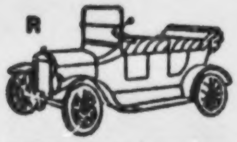

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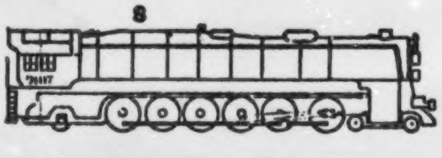

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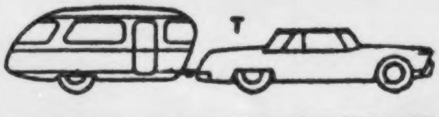


Source: The Aluminum Association

Student Worksheet

DEVELOPING TRANSPORTATION FOR PEOPLE AND PRODUCTS

(answer sheet)

1. B
2. H
3. A
4. Q
5. R
6. K
7. I
8. T
9. O
10. S
11. J
12. E
13. P
14. F
15. D
16. C
17. M
18. G
19. L
20. N

Source:

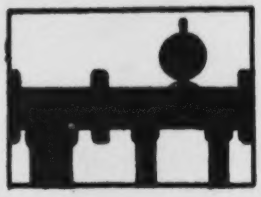
Student Worksheet

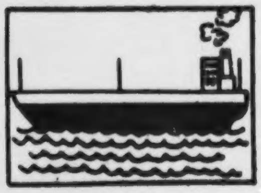
THE STORY OF OLIVIA OIL

Hi! I'm Olivia Oil. People tell me that I am very important because I help people. To find out how I can be useful, read my story.

To find me you must look in the ground. First dig a deep hole. Then use a pump to pull me out of the ground. Now I am called "crude oil".

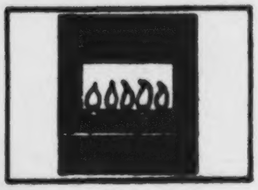
Next I go on a trip. I am put in a pipeline. Or else I am put in a big ship called an oil tanker. Then I am sent to an oil refinery.





An oil refinery is the place where I am turned into all different kinds of fuel.

Some of me is changed into gasoline to be used in cars and buses. Some is made into diesel fuel for use in trucks, cars, and ships. Another part of me is changed into heating oil that can be used to keep houses warm in the winter.

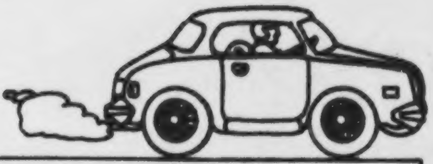


From the refinery, I travel by truck to wherever I am needed to do my job.

Source: National Science Teachers Association

REPORTER-ON-THE-STREET CORNER

YOUR CAR GETS ITS VERY BEST GAS MILEAGE WHEN IT IS SITTING IN YOUR DRIVEWAY.



20.8

DIRECTIONS: Interview three people you know who own cars. First, describe the car as *large* (8-cylinder, 4-door, van or truck) or *small* (6-cylinder, compact or sub-compact.) Then ask them their reasons for purchasing the kind of car they did, how many miles a week they drive, and how many miles per gallon of gasoline they get. As a final question, ask them if they believe there is in fact an energy shortage in this NATION.

	TYPE OF CAR	WHY THAT SIZE PURCHASED?	MILES PER WEEK	MILES PER GALLON
Owner 1 Energy shortage? ☐ yes ☐ no				
Owner 2 Energy shortage? ☐ yes ☐ no				
Owner 3 Energy shortage? ☐ yes ☐ no				

Student Worksheet

DRIVING TIPS:

1. Observe the 55 mph speed limit.
2. Avoid sudden starts and sudden stops.
3. Follow a program of regular car maintenance: oil changes, tune-ups, and so forth.
4. Use air-conditioning sparingly.
5. Avoid idling the motor for longer than 60 seconds.
6. Form car pools if possible; bicycle and walk.
7. Use public transportation for commuting.
8. Purchase energy-efficient cars.

Source: United States Department of Energy

Student Worksheet

ANNUAL FUEL COSTS CHART

Dollars Per Gallon

ESTIMATED MPG	1.40	1.30	1.20	1.10	1.00	0.90	0.80
50	$420	$390	$360	$330	$300	$270	$240
49	428	398	367	337	304	275	245
48	437	406	374	343	312	281	250
47	447	415	383	351	320	288	256
46	456	423	391	358	326	293	260
45	466	433	400	366	333	300	266
44	477	443	409	375	340	306	272
43	489	454	419	384	350	315	280
42	500	464	428	393	357	321	286
41	512	476	439	403	366	329	293
40	525	488	450	412	375	338	300
39	538	499	461	422	384	346	307
38	552	513	473	434	394	355	316
37	567	526	486	446	405	364	324
36	584	542	500	459	417	375	334
35	601	558	515	472	429	386	343
34	617	573	529	485	441	397	353
33	636	591	545	500	454	409	364
32	655	608	562	515	468	421	374
31	678	630	581	533	484	436	388
30	699	649	599	549	500	450	400
29	724	673	621	569	518	466	414
28	750	696	643	589	536	482	428
27	777	722	666	610	555	500	444
26	808	751	693	635	578	520	462
25	840	780	720	660	600	540	480
24	876	813	751	688	626	563	500
23	914	848	783	718	652	587	522
22	956	887	819	751	682	614	546
21	1000	928	857	785	714	643	571
20	1050	975	900	825	750	675	600
19	1105	1026	947	868	789	710	631
18	1168	1084	1001	917	834	751	667
17	1235	1147	1058	970	882	794	706
16	1312	1219	1125	1031	938	844	750
15	1401	1301	1201	1101	1000	900	800
14	1499	1392	1285	1178	1071	964	857
13	1615	1500	1384	1269	1154	1038	923
12	1749	1624	1499	1374	1250	1125	1000
11	1909	1773	1636	1500	1364	1227	1091
10	2100	1950	1800	1630	1500	1350	1200
9	2333	2166	2000	1833	1666	1500	1333
8	2625	2438	2250	2062	1875	1688	1500
7	3001	2787	2572	2358	2144	1929	1715
6	3501	3251	3031	2751	2500	2250	2000
5	4200	3900	3600	3300	3000	2700	2400

EXAMPLE: Gasoline is $1.20 per gallon. My car gets 41 miles per gallon (MPG). I will pay $439.00 per year for gasoline for my car. Pretend that gasoline goes up to $1.40 per gallon. My car gets 10 MPG. How much will gasoline cost me now? ____________________

Source: Environmental Protection Agency

Student Worksheet

THERE ARE OTHER WAYS TO GET FROM HERE TO THERE

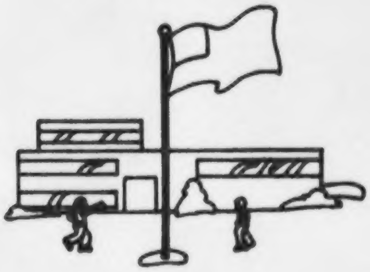
DIRECTIONS: With your house as the starting point in each case, talk with your family about the way to get to each destination listed below and write in the spaces provided (1) the distance in blocks or miles (2) another way of getting there other than the fmaily car and (3) the time in minutes or hours the other methods would take.

YOUR TOWN

SHOPPING CENTER

1. ______________________
2. ______________________
3. ______________________

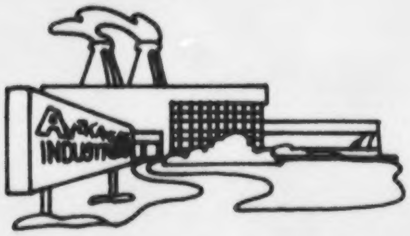
YOUR SCHOOL



1. ______________________
2. ______________________
3. ______________________

YOUR HOUSE

PARENT'S PLACE OF BUSINESS



1. ______________________
2. ______________________
3. ______________________

FAVORITE RESTAURANT

1. ______________________
2. ______________________
3. ______________________

FRIEND'S HOUSE

1. ______________________
2. ______________________
3. ______________________

Source: United States Department of Energy

LESSON #21

CATEGORY: Conservation

ENERGY TYPE: Oil, Gasoline

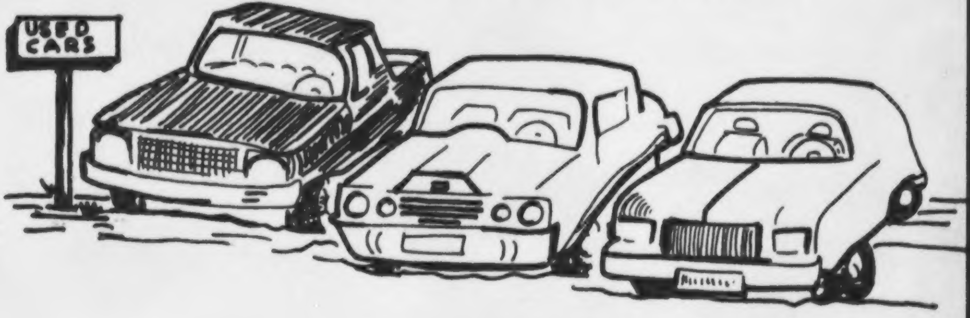
TITLE: U CAN S.A.V.E. (Save Arkansas' Vital Energy): Options and Choices

GRADE LEVEL: 4-6

TIME NEEDED: One period

INFUSE WITH SUBJECT AREA:

Consumer Education
Economics
Social Studies
Language Arts



MATERIALS:

Newspaper "wants ads"
Car advertisements

OBJECTIVE:

The students will choose one of the five possible energy conservation strategies that will work best for themselves and their families.

TASK ANALYSIS:

The students should be able to listen, accept opinions of others, and use decision making skills.

PROCEDURE:

1. Preparation

   Duplicate Student Worksheets 21.4 and 21.5.
   Note bulletin board suggestions (21.3).

2. Steps in Lesson

   Objective: The students will choose one of the five possible energy conservation strategies that will work best for themselves and their families.

   a. Divide the class into five groups.

   b. Distribute one of the situations from Student Worksheet 21.4 (Situations!) to each of the five groups. Have each group discuss the situation and then convince the other groups of its decision.

   c. Have the students look in a newspaper at automobile advertisements. Look under "Used Cars" and out of the first fifteen listed how many would be considered large cars, how many would be considered small cars, how many are relatively new, and how many are "loaded" (power equipment, air conditioning, automatic transmission, emission control devices, etc.)? Compare the cost of some of these cars with the price of new cars advertised in the same issue of the newspaper.

3. Evaluation

Distribute Student Worksheet 21.5 (The Conservation Planner). Discuss with the students, let them complete and then take it home so they can work out an "automobile-use budget" with their families.

4. Follow-Up Activities

Have the students research how ten, eleven, and twelve year old students in other nations get from one place to another.

GAS SAVERS

Looking for ways to save gas and money? One of the simplest solutions is to drive your car a little less. Here are six ideas you can use to keep your foot off the gas and more money in your pocket.

Call ahead to be sure you aren't wasting gas on an unnecessary trip. On the average, a wasted trip costs you a dollar's worth of gas.

Shop, bank and pay your bills by mail. A 15¢ stamp is a lot cheaper than a gallon of gas.

Ride a bike or take a hike. You'll feel more fit, and you'll have more money to spend when you get where you're going—since you didn't waste it on gasoline.

Ride to work with a friend or neighbor just one day a week and you can save at least $100 worth of gas every year.

Send me a free booklet with more easy tips on saving energy and money.

Name

Address

City State Zip

Mail to "Energy," Box 62, Oak Ridge, TN 37830.

Take public transportation as often as you can. You'll save gas and help reduce air pollution, too.

This free booklet can show you a lot more easy ways to save gas and money. To get your copy write "Energy," Box 62, Oak Ridge, TN 37830 or mail the coupon below.

ENERGY.

We can't afford to waste it.

U.S. Department of Energy

Student Worksheet

SITUATIONS!

Situation I:
Congress has just passed a law that the price of all luxury cars will increase $2000.00 and the taxes on gasoline will increase by five per cent. Your parents' salary stays the same. Your family wants a new car! Will your family buy that luxury car they have been dreaming of and sacrifice something else or will your family keep your small economy car that gets forty miles per gallon (mpg)?

Situation II:
Should gasoline be rationed? If so, how would your family use its portion? How would your parents get to work? How would you get to the doctor or Little League or friends or relatives?

Situation III:
The manufacturer of a new car called Smallo tells all the prospective buyers that if they will buy a Smallo they will reduce the price of the car by $1000.00. You and your family have been looking at a Bigo and had about decided on it because of all the luxury features. Now your parents are telling the family that perhaps they had better buy the Smallo. What are the reasons, besides the purchase price being reduced by $1000.00?

Situation IV:
Nearly every day you and your family go to the downtown business area. Suddenly the downtown area is closed to passenger cars. The traffic must stop. The officials are telling the public the reasons are that they want to encourage all of you to use public transportation and to decrease the amount of pollution in the area. Are you willing to comply - do what they say and stay out? How is this affecting you and your family?

Situation V:
There has been a bombardment of advertisements and encouragement on the part of public officials to convince you and your family that conserving energy will make us a more independent nation, can stretch the supply of fossil fuels, will give us time to develop other energy sources, and can save us dollars. Are you and your family convinced to conserve voluntarily? If so, what are some of the things you will do; if not, why not?

Student Worksheet

THE CONSERVATION PLANNER

DIRECTIONS: Five different strategies are often used to change people's behavior. These strategies can be used to encourage people to conserve energy, too. For each of the five examples given below, state what you would do in each case.

1. HIGHER PRICES OR TAXES

If the cost of school lunch desserts goes up, and your allowance does not, will you buy fewer desserts or go without somethng else to buy desserts?

2. ALLOCATION

If you could watch only two hours of television a day, how would you budget your time?

3. INCENTIVE

What would you do if your parents offered you a dollar to watch your little brother and you would rather play ball?

4. REGULATION

How would you feel if the town council said that only children under 8 years old could play in the park playground?

5. PERSUASION

If your leader at camp shows you the advantages of wearing raingear and boots when the weather is bad (your clothes stay dry; you can play in the puddles; you don't have to stay in the tent; and everyone else thinks it's a great idea), how do you react to his guidance?

FAMILY AUTOMOBILE-USE BUDGET

Together with your family, work out an "automobile-use budget" for one week. Write down on the reverse side of this page how the car will be used for the next seven days and try to stick to your plan. Combine trips; make only necessary trips; use footpower or bicycles whenever possible. Build any of the five strategies on this page into your plan.

Source: United States Department of Energy

GLOSSARY

Active solar system: System that needs mechanical means (pumps, fans, etc.) to harness direct solar energy.

Biomass: Living material and its waste products; usually limited to plant material: trees and other living plants, agricultural crop residues, forestry residues, animal manures.

British Thermal Unit (BTU): An engineering unit of heat energy; the quantity of heat necessary to raise the temperature of one pound of water one degree F. (about one-quarter of a calorie).

Coal: Solid, combustible organic material containing 55 to 90% carbon mixed with small amounts of hydrogen, oxygen, nitrogen, and sulfur.

Conversion, energy: Process of changing energy from one form to another (example: burning gasoline in an automobile: chemical energy to mechanical energy).

Demand, energy: Amount of energy required to satisfy energy needs.

Efficiency (conversion efficiency): Ratio of useful work or energy output to total work or energy input.

Electricity: Energy composed of moving electrons; for man, an intermediate form of energy which can be conveniently converted to mechanical energy or directly into heat or light.

Energy: Ability or capacity to do work by pushing or pulling some form of matter.

Energy crisis: Shortfall or catastrophic price rise for one or more forms of useful energy, or a situation in which energy use is so great that the resultant environmental degradation threatens human health and welfare.

Environment: Aggregate of external conditions that influence the life of an individual organism or population.

Fossil fuel: Remains of dead plants and animals of a previous geologic era that can be burned to release energy (examples: coal; crude oil; natural gas).

Fuel: Any material that can be burned or undergo nuclear fission or fusion to produce heat.

Geothermal energy: Heat energy produced when subsurface rocks are heated to high temperature by energy from the decay of radioactive elements in the earth.

Heating value: Amount of heat produced by the complete combustion of a unit quantity of fuel.

Hydropower: Conversion of mechanical energy in falling water to electrical energy by means of a turbine generator.

Kilowatt (KW): Measure of electrical output.

Natural gas: Natural deposits of gases consisting of 50 to 90% methane and small amounts of other hydrocarbons such as propane and butane.

Net useful energy: Total useful energy of a resource as it is found in nature minus the useful energy needed to find, extract, and process the resource, upgrade energy quality, meet environmental and safety requirements, and deliver the energy to the user minus the useful energy lost as a result of the Second Law of Thermodynamics and the uses of unnecessarily inefficient and wasteful energy systems.

Nonrenewable resource: Resource that can be used up or at least depleted to such a degree that further recovery is too expensive.

Nuclear energy: Energy liberated by a nuclear reaction (fission or fusion) or by radioactive decay.

Passive solar system: System that harnesses direct solar energy without mechanical devices; usually uses the structural design of a bulding to collect and convert solar energy.

Petroleum (or crude oil): Liquid, combustible organic material containing a mixture of hydrocarbon compounds plus small amounts of oxygen, sulfur, and nitrogen compounds and found in natural subsurface reservoirs; when refined produces many distillates, such as propane, fuel oil, kerosene, gasoline.

Photosynthesis: Complex process that occurs in the cells of green plants whereby sunlight is used to combine carbon dioxide and water to produce oxygen and simple sugar such as glucose.

Power: Rate at which work is done or energy is expended; measured in units of energy per unit of time such as calories per second, and in units such as watts and horsepower.

Propane: Hydrocarbon which exists under normal pressures and temperatures as a liquid; however, it gasifies easily and for many purposes it is a substitute for natural gas; main source of propane is from refining of crude oil.

Quality, energy: Ability of a form of energy to do useful work; high-quality energy (such as high-temperature heat, fossil fuels, and nuclear fuel) is concentrated, whereas low-quality energy (such as low-temperature heat and sunlight) is dispersed or diluted.

Renewable resource: Resource that potentially cannot be used up; either it comes from an essentially inexhaustible source (such as solar radiation), or it can be regenerated by natural or human-devised cyclical processes if it is not used faster than it is renewed.

Reserve, energy: That part of a total energy resource that has been identified and is generally capable of being developed under existing economic and technological conditions.

Resource, energy: Any material potentially useable by man as an energy source; includes estimates based on evidence for portions still undiscovered and those whose development will require more favorable economic conditions or better technology than presently exists.

Solar cell: Device, usually made of silicon, that converts sunlight directly into electricity; also known as photovoltaic cell.

Solar collector: Device which collects and converts solar energy into a more useful form.

Solar energy: Energy produced by the fusion reaction occurring in the sun, which reaches the earth as radiant energy.

Thermodynamics, First Law of (also known as the Law of Conservation of Energy): In any ordinary physical or chemical change, energy is neither created nor destroyed but merely changed from one form to another.

Thermodynamics, Second Law of (also known as the Law of Energy Degradation): In all conversions of heat energy to work, some of the energy is always degraded to a more dispersed and less useful form, usually heat energy given off at a low temperature to the surroundings, or environment.

Turbine: Rotary engine actuated by the reaction of a current of fluid (such as water) or gas (such as steam or air); usually made with a series of curved vanes on a central rotating spindle.

Wind energy: Mechanical energy of moving air.

SELECTED REFERENCES

Informational Materials for Teachers

ARKANSAS ENERGY OFFICE, 3000 Kavanaugh, Little Rock, AR, 72205. Call toll-free 1-800-482-1122 (or 371-1370 in Little Rock) for list of available titles.

ARKANSAS AND ENERGY: A LOOK AT THE ALTERNATIVES, by Paul L. Butt, 1979. 139 pp. Arkansas Ecology Center, P.O. Box 5754, Little Rock, AR, 72205. $3.00 plus 75 cents postage and handling (only prepaid orders accepted). A brief examination of the alternatives in Arkansas' energy future. In adjusting to scarcities and higher prices for energy, Arkansas will need to make some difficult decisions about increasing energy production and reducing energy consumption. Knowledge is essential to informed decision-making.

ENERGY, A GROWING NATIONAL PROBLEM, Illustrated 16 page report on our national energy problem and what can be done about it. Glossary of energy terms. Single copy free; additional 20 cents each; 50 or more, 16 cents each. National Wildlife Federation, 1416 Sixteenth St., NW, Suite 507, Washington, D.C. 20036.

ENERGY PUZZLE: HOW YOU FIT IN, Alliance to Save Energy, 1925 K Street, NW, Suite 507, Washington, D.C. 20006. Answers some of the questions about how we got where we are today and how we can solve some of our energy problems.

INK: World of Research, Inc., 11720 Sorento Valley Road, San Diego, CA 72121. Free for one, 2-9 copies $1.00. Magazine with current alternatives described; book reviews of energy books.

LEAGUE OF WOMEN VOTERS OF THE UNITED STATES, Sales Department, 1730 M Street, NW, 10th Floor, Washington D.C. 20036. Send the number of publication and a check for cost of publication plus 50 cents handling charge. "Energy Factsheet Kit" #552, $1.50, more than 20 sheets on all topics from offshore drilling to utility rate reform, 1974-79, 2 pp., each. "A Nuclear Waste Primer" #391, $1.25, 1980, 36 pp. "Energy Dilemmas: An Overview of U.S. Energy Problems and Issues", #688 $1.00 each, 5-9 copies are 80 cents each, 10-49 copies 70 cents, 1977, 39 pp. "Energy Options: Examining Sources and Defining Governments' Role", #628, $1.00 each or same rate as "Dilemmas", 1977, 55 pp. Ask for a catalog listing all League publications.

TIPS FOR ENERGY SAVERS: Order from Energy Conservation Now, Pueblo, Colorado 81009. Offers practical and simple ways to save energy in the kitchen, workshop, garden, and car; includes energy saving consideration when buying appliances and other household merchandise. 1978. 46 pp.

SELECTED DEPARTMENT OF ENERGY PUBLICATIONS: Order from U.S. Department of Energy-Technical Information Center, P.O. Box 62, Oak Ridge, Tennessee 37830. Available free upon request.

HOW TO UNDERSTAND YOUR UTILITY BILL: A guide to reading electric and gas meters and checking utility bills, so that householders may know how much energy they use and how effectively they conserve it. 1977. 12 pp.

I'VE GOT A QUESTION ABOUT USING SOLAR ENERGY: This pamphlet answers twelve of the solar questions most often asked by people writing to the Department of Energy. 1978. 32 pp.

OIL: Explains how oil is produced, transported, and used. 1977. 16 pp.

PROFESSIONAL ENERGY CAREERS: A brief outline of the professional careers in the energy field. 1979. 45 pp.

PUT THE SUN TO WORK TODAY: Solar principles, equipment, and costs for homeowners considering the installation of solar heating and cooling systems, in addition to a brief account of renewable energy obtainable from the winds, water power, photovoltaic cells, thermal conversions, biomass, ocean thermal, and satellite systems. 1978. 24 pp.

SOLAR ENERGY FOR AGRICULTURE AND INDUSTRY: How the sun can be used for a variety of applications, such as providing power to dry crops, heat farm buildings, and provide processed heat for industry. 1978. 9 pp.

FACT SHEETS: (Some sheets are quite technical)

1. Fuels from Plants (Bioconversion)
2. Fuels from Wastes (Bioconversion)
3. Wind Power
4. Electricity from the Sun I (Solar Photovoltaic Energy)
5. Electricity from the Sun II (Solar Thermal Energy Conversion)
6. Solar Sea Power (Ocean Thermal Energy Conversion)
7. Solar Heating and Cooling
8. Geothermal Energy
9. Energy Conservation: Homes and Buildings
10. Energy Conservation: Industry
11. Energy Conservation: Transportation
12. Conventional Reactors
13. Breeder Reactors
14. Nuclear Fusion
15. New Fuels from Coal
16. Energy Storage Technology
17. Alternative Energy Sources: Environmental Impacts
18. Alternative Energy Sources: A Glossary of Terms
19. Alternative Energy Sources: A Bibliography

Curricular Materials

Ordering information for the following curricular materials: U.S. Department of Energy-Technical Information Center, P.O. Box 62, Oak Ridge, Tennessee 37830: free single copies; lesson plans for teachers with student worksheets included. Bulk quantities/complete sets of individual titles sent only to teachers, librarians, or energy information centers. **Please use your official letterhead stationary in ordering.**

This material was produced by the National Science Teachers Association under contract with the U.S. Energy Research and Development Administration (Now U.S. Department of Energy). The facts, statistics, projections, and conclusions are those of the authors.

NETWORKS: HOW ENERGY LINKS PEOPLE, GOODS, AND SERVICES (grades 4-5). Six interdisciplinary lessons that investigate energy networks, such as electrical circuits, sources, conversions, and end use consumption. 1978. 100 pp.

SCIENCE ACTIVITIES IN ENERGY (grades 4-6). Below are a series of simple, hands-on science experiments designed to help students learn about various forms and sources of energy. File folder units include the following titles:

- **WIND ENERGY**
- **ELECTRICAL ENERGY**
- **SOLAR ENERGY I AND SOLAR ENERGY II**
- **CONSERVATION**
- **CHEMICAL ENERGY**

YOUR ENERGY WORLD (grades 4-6) for use with students; a set of four file folder units. Titles are listed below:

- **YOUR ENERGY WORLD: ENERGY OVERVIEW, UNIT ONE**
- **TRANSPORTATION: THE ENERGY EATER, UNIT TWO**
- **ENERGY USE IN HOMES AND STORES, UNIT THREE**
- **SCHOOLS CAN CONSERVE, TOO, UNIT FOUR**

SEED (School House Energy Efficiency Demonstration). Includes a classroom guide section with students sheets to duplicate so that students may conduct an energy survey of their school; activity lessons for grades 4-12 are included. Order a free copy from: Tenneco, Inc., Public Affairs Department, P.O. Box 2511, Houston, Texas 77001. (One copy was sent to each superintendent in Arkansas by Tenneco in May 1980.)

Films

Arkansas Energy Office has the following films for free loan. Call 371-1370 or toll free 1-800-482-1122 and tell when you want the film. The date you will receive the film will be confirmed by mail; return postage is to be paid by the school borrowing.

LEARNING ABOUT SOLAR ENERGY: (Received approximately 5/79). Demonstrates how solar energy works. It explains how to build small scale solar collectors, motors that run off the sun's energy, heating water, and many simple experiments. Elementary to Middle School. Very informative and enjoyable. 10 minutes.

TURN A HANDLE, FLICK A SWITCH: (Received approximately 5/79). This film explains where the gas, water and electricity in our homes is obtained. Elementary to Intermediate.

EVALUATION OF STUDYING ARKANSAS' VALUABLE ENERGY

Circle Unit Level K-3 4-6 7-12

Type of Class (math, science, social studies, etc.)____________________

Grade Level________Teacher's Name (Optional)____________________

School____________________City____________________

1. **CONTENT:** Did the students gain appreciably in energy knowledge and understanding?____yes____no. Describe____________________

2. **WORKSHEETS:** Were the student worksheets appropriate to the interests and abilities of your students?____yes____no. Describe____________________

3. **ATTITUDE:** Did the students' attitudes improve toward the importance of energy conservation?____yes____no. Describe____________________

4. **TEACHER BACKGROUND INFORMATION:** Was it adequate?____Inadequate?____

   Describe____________________

5. Energy topics which you would like to see included in future revisions.

6. Other comments (use back of page if needed)____________________

Return to: Helen Holmes, Coordinator of Economic, Energy, Environmental and Conservation Education; Arkansas Department of Education; Arch Ford Building, Room 404-B; Little Rock, AR 72201